P ?

AN INTRODUCTION TO THE LOGIC OF REFLECTION

BY

MATTHEW THOMPSON McCLURE
PROFESSOR OF PHILOSOPHY IN THE UNIVERSITY OF ILLINOIS

NEW YORK
HENRY HOLT AND COMPANY

PRINTED IN THE
UNITED STATES OF AMERICA

To

M. C. A. McC.

PREFACE

This text is the expression of an effort to assemble a body of material with which the student beginning the study of philosophy should become acquainted. In emphasizing the more directly empirical description of the procedure of reflection rather than the rigorous discipline of formal logic, no effort is made to disparage the latter. I believe that the drill in connection with the interpretation of propositions and syllogistic analysis is of the utmost disciplinary value, *provided* it is done thoroughly. But there simply is not time enough to do it thoroughly and during the same semester to accomplish anything else. I do not believe it is possible to effect any compromise in which both formal logic and the practical procedure of reflection can be presented within the limits of a semester.

The text contains numerous passages quoted from historical and contemporary philosophy. Two reasons have prompted me to incorporate these quotations: (1) To acquaint the student with the classical passages in philosophical literature which bear on logical analysis; and (2) To bridge the gap between the introductory and the subsequent courses given in philosophy, especially the history of philosophy. It is my view that the main undergraduate course in philosophy is the history of philosophy. Many students come into the his-

tory of philosophy with no preparation other than an elementary course in logic. It is hoped that the material presented in this book will provide both an introduction to philosophy and an analysis of the logic of reflection.

Two years ago the author published a brief description of reflective thinking for the use of men engaged in practical business. The book was published by the McGraw-Hill Company, and I am indebted to them for permission to use some of the illustrative material contained in that book.

That I have learned much from the logical writing of Professor Dewey is obvious on almost every page; and that indebtedness is frankly and gratefully acknowledged. I must also acknowledge much that I owe to the writings of Mr. Santayana.

M. T. McC.

University of Illinois,
March, 1925.

CONTENTS

CHAPTER PAGE

AN INTRODUCTION TO THE LOGIC OF REFLECTION

CHAPTER ONE

AN APPROACH TO THE STUDY OF LOGIC

1. The Meaning of Philosophy. The teaching of Logic by departments of philosophy has more than historical justification. Both in subject-matter and in method the two types of inquiry are inseparably bound together. In order to show the closeness of this relationship let us first seek to gain some idea of the meaning of philosophy.

To the early Greeks, the first among the peoples of Europe to have a philosophy at all, the word meant the same thing as the pursuit of wisdom. Those whom we, in retrospect, call philosophers did not call themselves philosophers. They called themselves "wise men." Not *philosophia,* therefore, but *Sophia,* or Wisdom, was the word which expressed their intellectual efforts. In one of his dialogues, the *Protagoras,* Plato gives a list of the seven wise men of Greece. In this list he includes the name of Thales, whom all historians of philosophy reckon as the first philosopher. Thales [1] has

[1] Thales (6th Cent. B. C.), a citizen of the Greek colony, Miletus.

been called the Benjamin Franklin of European thought. With a leaning toward politics, he combined moral wisdom and wise practical counsel with some knowledge about mathematics and physics and astronomy. The content of *Sophia,* or Wisdom, therefore, was the sum total of all that anybody knew about anything and everything.

The specific use of the word philosophy first occurs in Plato.[1] A philosopher, if we are to accept Plato's meaning of the word, is one who would like to be wise. Plato is very careful to distinguish the "wise man" from the "lover of wisdom." The wise men who lived just before and during Plato's life time called themselves "Sophists." Aside from the fact that Plato regarded the Sophists as the possessors of only apparent or specious wisdom, he further condemned them for having commercialized their knowledge; *i.e.,* for selling what they knew as if wisdom were one among the wares of the market. Truer to the theoretic spirit of the Greek, Plato taught that wisdom was a thing to be loved rather than a thing to be bought and sold. To say that philosophy is the love of wisdom is, of course, not to define philosophy; but it is to describe the philosopher's attitude of mind, an attitude characterized by a search for knowledge, not for what it

[1] Plato (427-347 B. C.), an ancient Greek philosopher.

is worth, but because knowledge is itself a desirable thing.

Plato says of a certain Greek named Stesichorus that he "was a philosopher and knew the reason why."[1] Neither is this a definition of philosophy, but it expresses the kind of wisdom which the philosopher seeks to attain. Knowledge of causes involving an intelligent understanding both of his own living and of the world he lives in is descriptive of the business of the philosopher. Thus writes Professor James:

> "I will tarry a moment, however, over the matter of definition. Limited by the omission of the special sciences, the name of philosophy has come more and more to denote ideas of universal scope exclusively. The principles of explanation that underlie all things without exception, the elements common to gods and men and animals and stones, the first *whence* and the last *whither* of the whole cosmic procession, the conditions of all knowing, and the most general rules of human action—these furnish the problems commonly deemed philosophic *par excellence;* and the philosopher is the man who finds the most to say

[1] *Phaedrus*, p. 243a.

about them. Philosophy is defined in the usual scholastic textbooks as 'the knowledge of things in general by their ultimate causes, so far as natural reason can attain to such knowledge.' This means that explanation of the universe at large, not description of its details, is what philosophy must aim at; and so it happens that a view of anything is termed philosophic just in proportion as it is broad and connected with other views, and as it uses principles not proximate, or intermediate, but ultimate and all embracing, to justify itself. Any very sweeping view of the world is a philosophy in this sense, even though it may be a vague one. It is a *Weltanschauung,* an intellectualized attitude towards life. Professor Dewey well describes the constitution of all the philosophies that actually exist, when he says that philosophy expresses a certain attitude, purpose and temper of conjoined intellect and will, rather than a discipline whose boundaries can be neatly marked off." [1]

But science also is interested in explanation and seeks to discover the causes of things. How then is philosophy to be distinguished from science? This

---

[1] *Some Problems of Philosophy,* pp. 4-6.

is an exceedingly difficult distinction to make, for neither the scientists nor the philosophers entirely agree on the exact terms of the distinction. Two things, however, can be said and the saying of them will help us forward in the preliminary work of definition.

First, philosophy differs from science in its *method* of inquiry. According to another characterization of philosophy given by Professor James, "philosophy is only an unusually obstinate effort to think clearly." A somewhat similar view is expressed by Hegel: "This *thinking study of things* may serve, in a general way, as a description of philosophy." In both these quotations we see that reflection is the prevailing method of philosophy. The philosopher thinks his way along. Science, on the other hand, advances by use of the *experimental* method. An hypothesis, for example, is a *scientific* hypothesis when it can be empirically and experimentally verified. The theory of unit characters in biology, for instance, is a scientific hypothesis because it is open to experimental testing. An investigation is scientific when the data involved are accessible to observation and open to empirical description and when the explanatory concepts are such that they fall within the sphere of experimental verification.

Philosophy, on the other hand, chiefly because of the nature of its subject-matter, must use a method other than experimentation. For the present this method may be characterized as the method of reflection. Thus atomism in modern chemistry is a scientific hypothesis. It was made so by the series of experimental investigations begun by Dalton. But atomism, as it was conceived and formulated by Democritus, was a philosophical hypothesis. It was philosophical because it was arrived at as a result of constructive reflective thinking. It would follow, of course, that many hypotheses pass from the realm of philosophy to that of science when, due to the increase of knowledge, they become accessible to empirical and experimental treatment. The contemporary establishment of psychology as a science is an example of the passage of a subject from the sphere of philosophy to that of science.

In the second place, philosophy differs from science in terms of the extension of its generalizations. The sciences are classified largely in terms of their subject-matter, and each science limits itself to its specialized field of inquiry and seeks to establish such verified generalizations as the nature of its subject-matter permits. When, however, it becomes necessary to go beyond a limited field of facts in search of verificatory material, when the

highest generalizations of any one science are considered in their relation to the generalizations of other sciences, the resulting interallied view, because of the breadth of its extent, is properly classed as philosophical. For example, the physicist may arrive at mechanism as a generalization descriptive of the activity of the physical order of things. But in order to establish mechanism as a world view, one would be compelled to go beyond physics and study biology and psychology, *etc.* When, therefore, we pass beyond the limits of a special science and reflect upon a specialized scientific generalization in its relation to the generalizations of other sciences, we pass from science to philosophy. It is not the business of the philosopher to conduct experimental investigations in any one of the separate sciences; it is his task to reflect upon the generalizations of all the sciences and out of them to formulate a unified and connected view of the world as a whole. The philosopher crosses border lines with impunity. He attempts to arrive at generalizations which are true, not from a point of view, or from the standpoint of a limited group of facts, but at generalizations which express something of the constitution of experience as a whole.

Combining the method of reflection with comprehensiveness of generalization, we may formulate the following provisional definition of phi-

losophy. *Philosophy is the attempt to do total and reflective thinking.*[1]

2. RELATION OF LOGIC TO PHILOSOPHY. How, then, is logic related to philosophy? It is related in two ways which may be termed methodological and inherent.

The methodological relation of logic to philosophy was first stated by Aristotle.[2] Inasmuch as Aristotle was the founder of logic and at the same time a great philosopher, we may well consider his way of conceiving the relationship of logic and philosophy. Aristotle was the first to undertake a classification of the sciences. Since his classification expresses the first division of the sum total of knowledge into separate types of inquiry, it will be both interesting and instructive to state it. The following diagram represents his scheme of division:

SCIENCE

Theoretical	*Practical*	*Productive*
Metaphysics (Theology)	Politics	Poetics
Mathematics	Politics	Rhetoric
Physics	Ethics	
Physics	Economics	
Biology		
Psychology		

[1] This definition is taken from Professor F. J. E. Woodbridge.

[2] Aristotle (384-322 B. C.), an ancient Greek philosopher.

The theoretical sciences have as their chief end the disinterested acquisition of knowledge; the practical sciences, the control and regulation of conduct; the productive sciences, the making of works of art. Now it will be observed that there is no place for logic in this scheme. It is the view of Aristotle that logic is not a separate science at all, but is a sort of bridge over which one passes in approaching any one of the sciences. It is "a part of general culture which every one should undergo before he studies any science."[1] The view that logic is a preparatory discipline is indicated in the title which was later assigned to the collection of Aristotle's logical writings. These writings, comprising five separate treatises, were "called the *Organon,* that is, the 'instrument,' or the body of rules of method employed by Science. The thought implied is thus that logic furnishes the *tools* with which every science has to work in establishing its results."[2] According to this view logic is just as much an introduction to physics or biology as it is to metaphysics or ethics in so far as these different inquiries involve a common methodology or are concerned with the nature of proof or the estimation of evidence.

[1] W. D. Ross, *Aristotle,* p. 20.
[2] A. E. Taylor, *Aristotle,* pp. 19-20.

In the main it seems admissible to accept the Aristotelian view that the study of logic affords a methodological approach both to philosophy and to the special sciences. But it is necessary to annex an important caution, namely, the danger of separating method from subject-matter. The method of scientific procedure is best studied in close connection with the subject-matter of science. The method of philosophical analysis is best learned in connection with concrete philosophical problems. That is to say, we do not first acquire a method and then proceed to apply it. The gap between the trained and the untrained mind is not bridged by superimposing a highly specialized technique on the beginner. Perfection of method comes gradually through contact with subject-matter. Of course, the import of this is merely to call attention to the *method* of studying methodology. But it should be remembered that however closely methodology is studied in connection with the concrete subject-matter of either science or philosophy, it is the methodology and not the subject-matter that is of concern to the logician.

In the second place, it does not seem inconsistent to say that logic, in addition to being a propaedeutic [1] to both philosophy and the special sciences,

[1] *i.e.,* a preparatory discipline.

is also *inherently* related to philosophy. This may be seen by reverting to the definition given of philosophy as total and reflective thinking. Whatever be the subject-matter about which one philosophizes, the prevailing method is that of reflection. Now it would seem to be a legitimate work of philosophy to scrutinize its own method of procedure. In so far, therefore, as logic expresses the effort to reflect upon reflection, it constitutes an inherent part of the subject-matter of philosophy.

This means, among other things, that the teaching of logic should be undertaken by the philosopher rather than by the special scientist. It may, however, be asked why this is so, since logic is a preparatory discipline to both science and philosophy. Reference has already been made to the distinction between philosophy and science on the basis of the difference between the method of reflection and the experimental method. Now reflection need not involve experimentation, but experimentation does involve reflection. This would seem to indicate that the experimental method considered *as* method falls within the province of reflection. Then, too, since the scientific method is that of experimentation, and since the scientist cannot experiment with the experimental method, any consideration of it as method falls outside the field

of science. But this difficulty does not beset the study of the philosophical method by the philosopher. One *can* reflect upon reflection. When, therefore, reflection itself becomes the object of total and reflective thinking, the resulting outcome, namely, logic, is an inherent part of the subject-matter of philosophy.

3. THE SUBJECT-MATTER OF LOGIC. Every topic of inquiry has a special subject-matter which is the object of its investigation. Physics, for example, investigates x. Chemistry investigates y. Now every investigation and every inquiry involves thinking; the special scientist not only investigates his subject-matter, he makes some effort to regulate his thinking. He has a technique for controlling his inferences and for testing his generalizations. But he is primarily interested in the investigation of his subject-matter and only secondarily interested in the control of his method of investigation.

Now what is of secondary interest to the special scientist is of primary interest to the logician. For the logician, thinking itself becomes a special object of investigation. He thinks about thinking. Thinking takes notice of itself, reflecting upon its own mode of operation, and estimating its own worth. One of the first philosophers of modern times to institute an inquiry into the nature and

conduct of reflection was John Locke.[1] He writes:

> "Since it is the understanding that sets man above the rest of sensible beings and gives him all the advantage and dominion which he has over them, it is certainly a subject, even for its nobleness, worth our labor to inquire into. The understanding, like the eye, whilst it makes us see and perceive all other things, takes no notice of itself; and it requires art and pains to set it at a distance and make it its own subject."[2]

When reflection, therefore, becoming conscious of itself, surveys the conditions necessary for its own effective operation, it creates the subject-matter of logic. The individual, while in the act of thinking, does not stop to scrutinize the processes which he is employing. He may seek to regulate and control his observation in a given instance, but he does not reflect upon observation in any general or critical way. He may guard against error in observation in a particular investigation, but he does not reflect on the general topic, "errors of observation." But one may subject the entire topic of observation to a general and critical analysis.

---

[1] John Locke (1632-1704), a British philosopher.

[2] *Essay Concerning Human Understanding,* Vol. I, p. 128.

In so doing he is creating the subject-matter of logic. A similar generalized and critical investigation of all the processes of reflection involves a logical subject-matter.

Since every one possesses the power of reflection, he has within himself the material necessary for the study of logic. He has only to make an examination of his own reflective procedure, to study the acts and operations of his own mind, in order to gain a first-hand acquaintance with the subject-matter of logic. But this fact gives to the study of logic both an advantage and a disadvantage. We may quote Hegel:[1]

> "From different points of view, Logic is either the hardest or the easiest of sciences. Logic is hard because it has to deal not with perceptions nor, like geometry, with abstract representations of the senses, but with pure abstractions; and because it demands a force and facility of withdrawing into pure thought, of keeping firm hold on it, and of moving in such an element. Logic is easy, because its facts are nothing but our own thought and its familiar forms or terms; and these are the acme of simplicity, the *a b c* of everything else. . . . But

[1] Hegel (1770-1831), a German philosopher.

> such an acquaintance only adds to the difficulties of the study; for while, on the one hand, we naturally think it is not worth our trouble to occupy ourselves any longer with things so familiar, on the other hand, the problem is to become acquainted with them in a new way, quite opposite to that in which we know them already." [1]

An ancient Greek philosopher, Heracleitus, in one of the fragments that has come down to us, says that "men are strangers to that with which they are continually familiar," [2] meaning, as Professor Woodbridge has suggested, that though men have minds they are not ordinarily aware of it. One of the advantages to be derived from the study of logic is that by such a study we are made critically conscious of the existence of our minds.

It would, however, be unwise to limit the subject-matter of logic to what we, by our own efforts at introspection, can find out about the nature of our own thinking. There is abundant material for the study of logic in the record of what past thinking has accomplished. This source of logical material has been well emphasized by Professor Creighton:

---

[1] *The Logic of Hegel,* English tr., W. Wallace, pp. 30-31.

[2] As translated by Professor F. J. E. Woodbridge.

"There is always a permanent body of knowledge which no one thinks of calling in question. Both in everyday knowledge, and in the sciences, there are a great number of propositions which are found true by everybody who takes the trouble to verify them. And it is here that logic finds its material. Taking the facts and propositions which are recognized as certain by every one, logic examines their structure in order to learn about the nature of the intellectual processes by which they have been discovered. What principles, it asks, are involved in these bodies of knowledge, and what particular acts of thought were necessary to discover them? It is only by examining various pieces of knowledge in this way, and attempting to trace out the conditions of their discovery, that one can learn anything new regarding the laws and character of thought. The best way of getting information about what thought can do, is to study what it has already accomplished. In other words, there is no way of learning about thinking except by studying what it has done."[1]

As an illustration of the logical reference of the

[1] *An Introductory Logic,* pp. 15-16.

foregoing passage, let us take the theory of evolution. The theory is a statement of "the reason why" the forms of animal life are as they are. What are the facts that call for explanation, and why is an explanation needed? How was the theory suggested? How was the suggestion worked up into a scientific explanation? By what method was it verified? What is the character and the force of the evidence adduced in support of it? What intellectual operations were involved in the discovery, formulation, and proof of the theory? How nearly sure can we be that the theory is true? How is the theory used as a means of finding out more facts about the nature of animal existence? One who attempts to answer these and similar questions is already well launched into the study of logic.

4. THE PURPOSE OF LOGIC. What is the task which logic sets for itself to perform? Its purpose is a double one, partly practical and partly theoretical.

(a) *Practical.* The first practical task of logic is the guidance of reflection. In this respect the logician describes the rules by means of which the process of reflection is correctly guided. It is his task to develop effective methods of inquiry and to safeguard the technique of investigation. The ob-

ject in this respect is not so much to tell us what we do when we think as it is to tell us what to do if we wish to improve our thinking. The logician attempts to place before the student such information as will be of use to him in increasing the fertility and effectiveness of his thinking. The fostering of right intellectual habits, the training of the mind in accurate methods of scientific procedure, the development of the power to do abstract thinking, are practical aims which fall within the legitimate exercise of logical discipline. As a practical art, logic is concerned with rules for the direction of the mind as it applies itself to problems of practical deliberation and scientific research.

The practical value of a knowledge of the processes in terms of which reflection goes has been well expressed by Socrates. After describing the manner in which certain logical processes operate, he says: "I am a great lover of these processes of division and generalization; they help me to speak and think."[1] In so far, I should suppose, as logical processes are used as aids in the communication of our ideas to others they properly fall within the field of rhetoric. But in so far as they are aids in individual thinking, they are strictly matters of logic. Now Socrates rightly sees that one who

[1] *Phaedrus*, 266a.

would excel in clear thinking must be a lover of logic. We may quote Hegel:

> "The utility of Logic is a matter which concerns its bearings upon the student, and the training it may give for other purposes. This logical training consists in the exercise in thinking which the student has to go through (this science is the thinking of thinking): and in the fact that he stores his head with thoughts, in their native unalloyed character. It is true that Logic, . . . is something more than merely useful. Yet if what is noblest, most liberal and most independent is also most useful, Logic has some claim to the latter character. Its utility must then be estimated at another rate than exercise in thought for the sake of the exercise."[1]

In the second place, it is the object of logic to furnish a basis of criticism. Among the Greeks, Socrates was a specialist in the art of criticism. He frankly admitted that he himself had nothing to say and he spent a good deal of his time in trying to persuade others that it would be wise for them to make similar admissions about themselves. He was fond of putting questions to young men and

[1] *The Logic of Hegel*, p. 31.

then showing them that their answers were foolish. He is represented by Plato as having put the following question to a young man: "What is piety and what is impiety?" The young man replied: "Piety is doing as I am doing; that is to say, prosecuting any one who is guilty of murder, sacrilege, or of any other similar crime—whether he be your father or mother, or some other person, that makes no difference—and not prosecuting them is impiety." Socrates then says: "Remember that I did not ask you to give me two or three examples of piety, but to explain the general idea which makes all pious things to be pious." And then he adds: "Tell me what that is, and then I shall have a standard to which I may look, and by which I may measure the nature of actions, whether yours or any one's else, and say that this action is pious, and that impious." [1]

Only one who knows what piety is can be a competent critic of pious acts. One who is in possession of such knowledge not only knows *that* a specific case is an example of piety, but he knows *why* it is so. He has a standard and the standard serves as a basis of criticism. We are continually passing judgments of approval and of disapproval on the actions of our fellow men. This act, we say,

[1] *Euthyphro*, p. 6.

is praiseworthy, and that one is culpable. It is one thing to pronounce such judgments, and it is quite another to know "the reason why." Now it belongs to the special science of ethics to furnish us with a basis of criticism for all of our moral judgments.

Similarly, if we are called upon to distinguish good pictures from bad ones, we must have some standard, some general idea about the nature of beauty. It is the business of the teacher of art criticism to furnish us with a basis for our judgments of esthetic appreciation.

And in a similar way we pass judgments on the correctness or incorrectness of our thinking. We say that the inference is unwarranted, that the reasoning is unsound, that the conclusion is illogical, that the evidence is inconclusive. Again, we may know *that* the thinking is illogical and false, but *why* it is false and precisely in what its falsity consists we may not know. It is the business of the logician to put us in possesssion of a basis of criticism by means of which we can judge the validity and worth of our reasoning.

Let us turn to illustrations. "All express trains carry the mail. The last train carried the mail, and was, therefore, an express train." Or we may shift the form of our minor premise and say: "All express trains carry the mail; the last train was an

express train, and therefore carried the mail." Now one of these conclusions is false and the other one is true. Why? We may take another illustration. Mr. Saintsbury in a book on *Letters* as a form of literary composition says: "Women write the best letters and have the best letters written to them." Now what inferences may we safely draw from these two statements? X, let us say, is a best letter. Could a man have written it? Does a man ever receive a best letter? Do women ever write their best letters to each other? How can we be sure that our answers to these questions are absolutely certain?

Mr. Bertrand Russell begins a book on *The Problems of Philosophy* as follows:

> "Is there any knowledge in the world which is so certain that no reasonable man could doubt it? This question, which at first sight might not seem difficult, is really one of the most difficult that can be asked. When we have realized the obstacles in the way of a straightforward and confident answer, we shall be well launched on the study of philosophy—for philosophy is merely the attempt to answer such ultimate questions, not carelessly and dogmatically, as we do in ordinary life and

> even in the sciences, but critically, after exploring all that makes such questions puzzling, and after realizing all the vagueness and confusion that underlie our ordinary ideas."[1]

Logic, which for Mr. Russell is synonymous with philosophy, is the study which sets for itself the task of describing the technique by means of which we criticise and evaluate our ideas and beliefs.

One of the essential characteristics of good thinking is consistency. Many of us, not having subjected our beliefs to a critical analysis, hold to views which are mutually inconsistent and contradictory. Criticism, remarks Mr. Santayana, marks the difference between what I thought I knew and what I find I know. Plato represents Socrates as one who was especially skillful in detecting the confusion of thought arising from attachment to uncritical beliefs and in limiting our knowledge to what we find we do actually know. In a dialogue entitled *Protagoras* he describes a long discussion between Socrates and Protagoras on the question whether virtue can be taught. The argument ends in confusion chiefly because the view held by each is inconsistent with certain other views advocated by each with equal confidence.

[1] B. Russell, *The Problems of Philosophy*, p. 1.

Seeing the need for a more critical examination of the arguments, Socrates says:

> "The result of our discussion appears to me to be singular. For if the argument had a human voice, that voice would be heard laughing at us and saying: Protagoras and Socrates, you are strange beings; there are you who were saying that virtue cannot be taught, contradicting yourself now in the attempt to show that all things are knowledge, including justice, and temperance, and courage—which tends to show that virtue can certainly be taught for if virtue were other than knowledge, as Protagoras attempted to show, then clearly virtue cannot be taught; but if virtue is entirely knowledge, as you, Socrates, are seeking to show, then I cannot but suppose that virtue is capable of being taught. Protagoras, on the other hand, who started by saying that it might be taught, is now eager to show that it is anything rather than knowledge; and if this is true, it must be quite incapable of being taught. Now I, Protagoras, perceiving this terrible confusion of ideas, have a great desire that they should be cleared up." [1]

[1] *Protagoras*, p. 361.

Furthermore, it is not only the purpose of logic to furnish a basis of criticism, it is also its purpose to develop a critical attitude of mind. It should encourage one to foster and exercise an inquisitive and speculative interest in intellectual activity. Plato says that philosophy begins in wonder. And in a very real sense, it may also be said to end there. Although, it should be added, in the end one has more to wonder about than he had in the beginning. The method of wonder is Plato's favorite method. In a famous passage he describes the first fit of metaphysical fever which takes possession of a young man with his first taste of logic.

> "Any young man, when he first tastes these subtleties, is delighted, and fancies that he has found a treasure of wisdom; in the first enthusiasm of his joy he sets (not every stone, but) every thought rolling, now converting the many into the one, and kneading them together, now unfolding and dividing them; he puzzles himself first and above all, and then proceeds to puzzle his neighbors, whether they are older or younger, or of his own age—that makes no difference; neither father nor mother does he spare; no human being who has ears is safe from him, hardly even his dog,

and a barbarian would have no chance with him, if an interpreter only be found."[1]

Consider one such puzzle. The Sophist, Protagoras, undertook to teach a certain Greek boy the subject of law. It was agreed that the boy was to pay for his legal instruction when he won his first case in court. After two years of instruction, however, the boy decided not to practice law, hoping in this way to render himself exempt from the payment of his fees. But taking advantage of the fact that in Athens every one must make his own defense when involved in legal proceedings, Protagoras sued the boy, thereby involving him in a lawsuit. Protagoras argued as follows: In this case I must either win or lose. If I lose, according to our former agreement the boy must pay, and if I win, according to the decision of the court he must pay; so in either case he must pay. But the lad had evidently profited from the teachings of his wise instructor, and replied with a counter dilemma: It is also true that I must either lose or win. If I lose, according to our former agreement I am not to pay; and if I win, according to the decision of the court I am not to pay; so in either case I am not to pay.

---

[1] *Philebus*, p. 150.

(b) *Theoretical.* Theoretically, it is the purpose of logic to tell us how we think. This involves a description of the processes, distinctions, and concepts in terms of which thinking goes on. In this respect, logic is a science, but it should be remembered that it is essentially an empirical science. That is to say, the subject-matter of logical theory is open to observation and natural description. The principles invoked in the explanation of reflection are neither theories nor hypotheses, but are empirically verifiable and observable elements of description.

Logic, therefore, is both a science and an art. "A process becomes an art," says Mr. Santayana, "when its aim is conscious and its method is teachable." To say that thinking is of logical significance is to say that reflection has become conscious of itself. And the method by means of which it operates is teachable. But art rests on science. The more we know *why,* the better we know *how.* Skill in the exercise of intelligence depends on a knowledge of the nature of intelligence. To quote Professor Dewey:

> "In language familiar to students, logic is both a science and an art; a science so far as it gives an organized and tested descriptive ac-

count of the way in which thought actually goes on; an art, so far as on the basis of this description it projects methods by which future thinking shall take advantage of the operations that lead to success and avoid those which result in failure."[1]

The following passage from Aristotle is well worth study:

"The animals other than man live by appearances and memories, and have but little of connected experience; but the human race lives also by art and reasonings. And from memory experience is produced in men; for many memories of the same thing produce finally the capacity for a single experience. Experience is almost identified with science and art, but really science and art come to men *through* experience; for 'experience made art,' as Polus says, and rightly, 'but inexperience luck.' And art arises, when from many notions gained by experience one universal judgment about a class of objects is produced. For to have a judgment that when Callias was ill of this disease this did good, and similarly in the case of Socrates and in many individual

[1] *Reconstruction in Philosophy,* p. 155.

cases, is a matter of experience; but to judge that it has done good to all persons of a certain constitution, marked off in one class, when they were ill of this disease, e.g. to phlegmatic or bilious people when burning with fever, this is a matter of art.

"With a view to action experience seems in no respect inferior to art, and we even see men of experience succeeding more than those who have theory without experience. The reason is that experience is knowledge of individuals, art of universals, and actions and productions are all concerned with the individual; for the physician does not cure *man,* except in an incidental way, but Callias or Socrates or some other called by some such individual name, who happens to be a man. If, then, a man has the theory without the experience, and knows the universal but does not know the individual included in this, he will often fail to cure; for it is the individual that is to be cured. But yet we think that *knowledge* and *understanding* belong to art rather than to experience, and we suppose artists to be wiser than men of experience (which implies that Wisdom depends in all cases rather on knowledge); and this because the former know the

cause, but the latter do not. For men of experience know that the thing is so, but do not know why, while the others know the 'why' and the cause. Hence we think that the master-workers in each craft are more honorable and know in a truer sense and are wiser than the manual workers, because they know the causes of the things that are done (we think the manual workers are like certain lifeless things which act indeed, but act without knowing what they do, as fire burns—but while the lifeless things perform each of their functions by a natural tendency, the labourers perform them through habit); thus we view them as being wiser not in virtue of being able to act, but of having the theory for themselves and knowing the causes."[1]

5. THE MEANING OF LOGIC. Let us now, by way of summarizing the foregoing discussion, briefly characterize the meaning of logic. We do not at present propose to formulate a strict definition of logic. But it is quite possible to indicate the type of inquiry that will be undertaken in the following chapters. It is possible to outline a program that will serve to guide the student in his approach to the subject.

---

[1] *Metaphysics*, 981.

Logic may be characterized as an empirical description (1) of the processes of reflection, (2) of the rules governing its effective exercise, and (3) of the canons and standards in accordance with which its validity is judged.

Each of these three types of inquiry falls legitimately within the scope of logic, or at least within the scope of logic as that subject is conceived in the following treatment. The first type of inquiry is concerned with the operation of reflection, that is, with reflection as a process. It involves an analysis and description of the concepts and distinctions in terms of which reflection is made intelligible. It is in this sense that logic is a science. From this standpoint it is the business of logic to explain fully the meaning of such terms as inference, evidence, truth, cause, theory, hypothesis, law, generalization, demonstration, consistency, explanation, *etc.* In short, it is the task of logic to give a generic account of our reflective behavior. The second type of inquiry is concerned with the development of competence and skill in the exercise of intelligence. It is in this sense that logic is an art. The third type of inquiry is concerned with the worth and validity of thinking. It undertakes to equip one with a technique for estimating the truth or falsity of his beliefs. From this standpoint, logic is not so much concerned with the *why*

of things as it is in explaining why the "why" is a why. It is in this sense that logic is peculiarly a "normative" science.

Many logicians would limit the scope of logic to the third type of inquiry. I do not propose to argue the advisability or inadvisability of this limitation. What seems to me of importance is that the student become acquainted with the subject-matter referred to in the three types of inquiry.

It should further be stated that the three types of investigation are not considered separately in the sequel. All three are intrinsically bound together. The validity of knowledge, as expressing the results of reflection, cannot be judged apart from the process that leads up to it.

QUESTIONS

1. What is the meaning of philosophy according to James?
2. How is philosophy to be distinguished from science?
3. Contrast the "method of reflection" with the "method of experimentation."
4. Why cannot any one of the sciences give an adequate view of reality as a whole? Is it possible to have an experimental knowledge of reality as a whole?
5. How is philosophy defined?
6. What is Aristotle's view of the relation of logic to science?
7. Explain the meaning of "Organon" as the title given to Aristotle's logical writings.

8. Why should the philosopher rather than the special scientist teach logic?

9. From what two sources does the logician derive his subject-matter?

10. Why, according to Hegel, is logic both hard and easy?

11. Does the logician use the "introspective" method?

12. Distinguish logic from rhetoric.

13. What practical value do you expect to derive from the study of logic?

14. Illustrate Mr. Santayana's definition of criticism.

15. How do you distinguish the theoretical from the practical aspect of logic?

16. Does logic teach us how we think or how we ought to think, or both?

17. How do you distinguish a science from an art?

18. Relate the foregoing distinction to logic.

19. Does "knowledge how" always involve "knowledge why," or *vice versa?*

20. In the closing quotations from Aristotle (1) what is meant by "experience" and what is meant by "art"; and (2) in what sense is art superior to experience, and in what sense inferior?

21. Compare the use of the terms "art" and "experience" in the closing quotation from Aristotle with the distinction between "theoretical" and "practical" as given in the classification of the sciences on page 10.

EXERCISES

1. Look up something of the life of Thales.

2. Describe the character and content of *Sophia, i. e.,* the kind of wisdom which before Plato was called philosophy.

3. What do you know about the ancient Greek Sophists? See: J. E. Creighton, *An Introductory Logic,* pp. 19-23.

4. Relate the statement of Socrates: "The unexamined life is unworthy to be lived," with Plato's characterization of Stesichorus.

5. Is the Einstein theory of relativity a scientific or a philosophical hypothesis?

6. Give two illustrations of scientific hypotheses and two illustrations of philosophical hypotheses.

7. Relate the quotation from Heracleitus to the Hegelian view that logic is hard.

8. Discuss: "Logic is concerned not only with the process of deriving our beliefs, but with their justification." What two aspects of logic does this emphasize?

9. Develop the distinction between "descriptive" and "normative" sciences. Give two illustrations of each.

10. How do you answer the questions stated in the first paragraph on page 24?

11. How would you settle the dispute between Protagoras and his legal student?

12. (a) What is meant by an "empirical" science? (b) Illustrate what you would consider a non-empirical science. (c) Illustrate the empirical and non-empirical sense in which the word "theory" is used. (d) Is logic empirical? (e) If you were to say that philosophy is non-empirical and that logic is empirical, could you then say that logic is inherently related to philosophy?

13. Formulate in your own language what you conceive to be the meaning of "logical" when you say, for example, "Your reasoning is not logical."

14. Briefly summarize the topics discussed in the chapter.

CHAPTER TWO

THE MEANING OF REFLECTION

Let us now turn to a more precise analysis of the meaning of reflection. We must narrow the word down to its strict logical signification. We may begin with a distinction made by Thomas Hobbes:[1]

> "This train of thought, or mental discourse, is of two sorts. The first is *unguided, without design,* and inconsistent; wherein there is no passionate thought to govern and direct those that follow, to itself, as the end and scope of some desire, or other passion: in which case the thought is said to wander, and seem impertinent one to another, as in a dream. Such are commonly the thoughts of men, that are not only without company, but also without care of anything; though even then their thoughts are as busy as at other times, but without harmony; as the sound which a lute out of tune would yield to any man, or in tune to one that could not play. . . .

[1] Thomas Hobbes (1588-1679), a British philosopher.

"The second is more constant, as being *regulated* by some desire, and design. For the impression made by such things as we desire, or fear, is strong and permanent, or, if it cease for a time, of quick return: so strong it is sometimes, as to hinder and break our sleep. From desire, ariseth the thought of some means we have seen produce the like of that which we aim at; and from the thought of that, the thought of means to that means; and so continually till we come to some beginning within our own power. And because the end, by the greatness of the impression, comes often to mind, in case our thoughts begin to wander, they are quickly again reduced into the way; which observed by one of the seven wise men, made him give men this precept, which is now worn out, *Respice finem;* that is to say, in all your actions, look often upon what you would have as the thing that directs all your thought in the way to attain it." [1]

Thinking, accordingly, is of two kinds which we may term undisciplined imagination and reflection. Let us describe and characterize each type more in detail.

[1] Quoted from Rand, *Modern Classical Philosophers,* pp. 65-66.

1. Undisciplined Imagination. The first type of thinking Hobbes further characterizes as "the wild ranging of the mind." This kind of thinking takes many forms. Rumination, day-dreaming, fancy, mind-wandering, reverie, wool gathering are typical examples. The mind, released from the tension and pressure of concentration, falls away into loose and idle dreaming. Such thinking often takes the form of a dramatic rehearsal of events in which we appear as "suffering heroes" or as "injured martyrs."

The following description from Professor Robinson illustrates this kind of thinking:

> "When we are offered a penny for our thoughts we always find that we have recently had so many things in mind that we can easily make a selection which will not compromise us too nakedly. On instruction we shall find that even if we are not downright ashamed of a great part of our spontaneous thinking it is far too intimate, personal, ignoble, or trivial to permit us to reveal more than a small part of it. I believe this must be true of everyone. We do not, of course, know what goes on in other people's heads. They tell us very little and we tell them very little. The spigot of

speech, rarely fully opened, could never emit more than driblets of the ever renewed hogsheads of thought—*noch grosser wie's Heidelberger Fass.* We find it hard to believe that other people's thoughts are as silly as our own but they probably are.

"We all appear to ourselves to be thinking all the time during our waking hours, and most of us are aware that we go on thinking while we are asleep, even more foolishly than when awake. When uninterrupted by some practical issue we are engaged in what is now known as *reverie.* This is our spontaneous and favorite kind of thinking. We allow our ideas to take their own course and this course is determined by our hopes and fears, our spontaneous desires, their fulfillment or frustration; by our likes and dislikes, our loves and hates and resentments. There is nothing else anything like so interesting to ourselves as ourselves. All thought that is not more or less laboriously controlled and directed will inevitably circle about the beloved Ego. It is amusing and pathetic to observe this tendency in ourselves and in others. We learn politely and generously to overlook this truth, but if we

dare to think of it, it blazes forth like the noontide sun."[1]

Imaginative thinking was also recognized and described by Plato:

"Let me feast my mind as day-dreamers are in the habit of feasting themselves with their own dreams when they are walking alone; for before they have discovered any means of effecting their wishes—that is a matter which never troubles them—they would rather not tire themselves by thinking about possibilities; but assuming that what they desire is already theirs, they pursue their plan, and delight in detailing what they are going to do when their wish has come true; that is a way which they have of not doing much good to a capacity which never was good for much."[2]

Mr. Santayana has well described the character and significance of this imaginative dream world:

"Every actual animal is somewhat dull and somewhat mad. He will at times miss his signals and stare vacantly when he might well

[1] *Mind in the Making*, pp. 37-38.
[2] *Republic*, 458a.

act, while at other times he will run off into convulsions and raise a dust in his own brain to no purpose. . . . The intelligent man known to history flourishes within a dullard and holds a lunatic in leash. . . . He is amused by the antics of the brute dreaming within his breast; he gloats on his passionate reveries, an amusement which sometimes costs him dear. Thus the best human intelligence is still decidedly barbarous; it fights in heavy armour and keeps a fool at court. . . .

"An imaginative life may therefore exist parasitically in a man, hardly touching his action or environment. There is no possibility of exorcising these apparitions by their own power. A night-mare does not dispel itself; it endures until the organic strain which caused it is relaxed either by natural exhaustion or by some external influence. Therefore human ideas are still for the most part sensuous and trivial, shifting with the chance currents of the brain, and representing nothing, so to speak, but personal temperature. Personal temperature, moreover, is sometimes tropical. There are brains like a South American jungle, as there are others like an Arabian desert, strewn with nothing but bones. While

a passionate sultriness prevails in the mind there is no end to its luxuriance." [1]

The above descriptions are sufficient to enable us to identify this type of thinking. We may now proceed to point out its outstanding traits. Undisciplined imagination is unsystematic, uncontrolled, and uncritical. Thoughts succeed each other in a series where each is bound to the other by no bond other than chance association or emotional congruity. The thinking subserves no purpose beyond the emotional relaxation of the moment. No effort is made to direct the stream of thought. The thinking is without direction; it lacks order, is aimless and random.

Thinking of this loose and uncritical type is altogether unrelated to action. The life of the imagination and the life of action are often lived in almost complete separation. While, for example, we are occupied in doing something with our hands, our minds are engaged in a reverie of the imagination, enacting scenes far removed from the spatial context in which our bodies and our actions are set. Most of the thoughts that go through our heads are too fantastic to be relevant to practice and too dreamful to be applicable to action.

[1] *Life of Reason,* Vol. I, pp. 50-53, *passim.*

Imaginative thinking is native and unlearned. It occurs spontaneously, naturally, and inevitably. No one can learn to think any more than he can learn to live. Imagination is as natural an operation of an animal body as breathing or as digestion. We can no more stop it than we could stop any other primary vital function. It is as natural for ideas to germinate and sprout in the imagination as for weeds to grow on fertile soil. Just as we say it rains, or it freezes, we say "it" thinks. Raining requires no agency for its occurrence, all that is required is a factual statement of what is going on. Thinking, like breathing, is a vital operation that goes on. It just occurs. It is as much an original and spontaneous expression of the energies of life as the circulation of the blood. Ideas are attached to the body and it is only subsequently that they are utilized in its service. The fact of thought antedates its efficacy.

In the process of imagination, however, we have the central factor in thinking, namely, the representation in thought of what is absent and distant in space and time. Thinking is thus contrasted with sense perception. The object of perception, that is, the thing perceived, is directly and immediately present to the senses. But the object of thought is a represented object. I see the cloud; I think *of*

rain. The rain, a thing which is yet to come, is represented to thought. Imagination is a sort of mirror which reflects not only the absent in space but the distant in time. It is thus that we can transcend the limitations of sense. By means of its power to envisage the absent, the mind is free to range far and wide. As Mr. Santayana writes:

> "So soon as man ceases to be wholly immersed in sense, he looks before and after, he regrets and desires; and the moments in which prospect or retrospect takes place constitute the reflective or representative part of his life, in contrast to the unmitigated flux of sensations in which nothing ulterior is regarded."[1]

Representation, which is the essence of imagination, is the crucial trait or central factor in thinking. Professor Dewey uses the word "suggestion" to stand for this familiar function of representation. The cloud suggests rain, rain suggests an umbrella, the umbrella suggests the friend who gave it to me. The word will later have to be subjected to a critical analysis, but for the present we may accept it as the most suitable one to convey the meaning involved in the function of envisage-

[1] *Life of Reason,* Vol. I, p. 2.

ment. The important thing to note at present is that suggestion is a natural happening. As Professor Dewey remarks: "It is as certain that one thing suggests another as that fire alters the thing burned."[1] Suggestion and combustion are on the same level of reality and belong to the same order of existence. It is just as much and just as little possible to say why a column of mercury suggests rain as it is to say why it rises and falls with corresponding changes in temperature. Suggestiveness is as much a property of things as whiteness or roundness.

For our purposes, perhaps the most significant trait of undisciplined imagination is the total absence of anything like logical significance. This means, in the first place, that this type of thinking falls outside the field of logic. It also means that imaginative thinking is lacking in logical properties. As we shall see later, the meaning of logical is to be found partly in the control and regulation of our thoughts and the shaping of them with reference to some end or purpose. And it is just this trait which is so conspicuously absent in the kind of thinking we have been describing.

2. Reflective Thinking. There is a second

---

[1] *Essays in Experimental Logic*, p. 47.

kind of thinking easily recognizable and which may be readily identified. It is the kind of thinking we do when struggling to solve some problem or to surmount some obstacle. It is an active and constructive process in which we debate with our thoughts and arrange them with reference to some need or purpose. Before making a decision involving important consequences we reflect. We do not just think, allowing our thoughts to present themselves in a casual and random order; we think *about* the subject of our momentary interest and reflect *over* the special problem that engages our attention. Deliberation, choice, decision, judgment are traits of this type of thinking. Several times a day problems arise which demand reflection as a means of their solution. Thinking of this description is a thing that we do at specific need. Reflection occurs at those critical junctures of experience when some difficulty or emergency arises. It then becomes necessary to consider alternatives, to weigh evidence, to draw inferences. Our attitude becomes critical and our thinking becomes purposeful in order that our decision may be deliberate and our action appropriate. It is the kind of thinking that issues in action; things depend on it, and consequences follow from it. We may quote from Mill:

> "To draw inferences has been said to be the great business of life. Every one has daily, hourly, and momentary need of ascertaining facts which he has not directly observed; not from any general purpose of adding to his stock of knowledge, but because the facts themselves are of importance to his interests or to his occupations. The business of the magistrate, of the military commander, of the navigator, of the physician, of the agriculturist, is merely to judge of evidence, and to act accordingly. They all have to ascertain certain facts, in order that they may afterward apply certain rules, either devised by themselves or prescribed for their guidance by others; and as they do this well or ill, so they discharge well or ill their several callings. It is the only occupation in which the mind never ceases to be engaged. . . ."[1]

In this kind of thinking, we discover the character of personality. No longer does "it" think, but "I" think. This does not mean that there is an independent agent that produces thoughts as a mint might turn out coins. Thoughts require no agent

[1] J. S. Mill, *A System of Logic*, p. 21.

to think them any more than circulation of blood requires a circulator. The process of thinking, as we have seen, just goes on. It is a work of hypostatization to turn the process into a thing and set it behind the process as an entity in terms of which the process is to be explained. Personality as an entity separate and apart from the concrete operations of thought is a trailing relic of animism. Grote says that Greek philosophy began when men left off asking Who rains? and began an investigation of the conditions and factors entering into the precipitation of moisture. And so we must not ask Who thinks? but undertake an analysis of the processes entering into reflection. Instead of the loose dispersion of thoughts characteristic of uncontrolled thinking we have a tense magnetization of ideas arranged around a center. Personality is in part the product of the structure of thought. That is to say, it is the purposeful *order* which is introduced into thinking on the reflective level that signifies personality. It is the end or purpose of thinking which gives unity to the process and binds its various phases into an integrated whole. And in part personality is the measure of resistance. I know myself as a "self" by the obstacles I encounter. If ideas met no resistance in

their embodiment in action, but were, like the activities of divine art, immediate and instantaneous realizations, reflection would have no use and personality would have no existence. Beings who gained their ends as easily as they conceived them might be angels; they certainly would not be men. Human beings know themselves as personalities only in their frustrations.

If we look for the chief traits of reflection we find them to be three: the examination of evidence, the exercise of control, and the operation of belief.

Reasoning is primarily concerned with evidence. The function of representation, or as Professor Dewey terms it, suggestion, is the central factor in thinking. Now suggestion in and of itself is of no logical significance. But in reflection the suggestion is tentatively entertained pending investigation. An examination of the grounds supporting it and the consequences implied in it are undertaken. The logical task in connection with evidence is twofold: (1) to collect evidence; (2) to tell whether what is collected is evidence. The first deals with the operation of reflection; the second with the results of thought.

Some logicians, for example John Stuart Mill, would limit the business of logic to the second task; namely, the determination of evidence. He writes:

"Logic is the common judge and arbiter of all particular investigations. It does not undertake to find evidence, but to determine whether it has been found. Logic neither observes, nor invents, nor discovers; but judges. It is no part of the business of logic to inform the surgeon what appearances are found to accompany a violent death. This he must learn from his own experience and observation, or from that of others, his predecessors in his particular pursuit. But logic sits in judgment on the sufficiency of that observation and experience to justify his rules, and on the sufficiency of his rules to justify his conduct. It does not give him proofs, but teaches him what makes them proofs, and how he is to judge them. It does not teach that any particular fact proves any other, but points out to what conditions all facts must conform, in order that they may prove other facts. To decide whether any given fact fulfills these conditions, or whether facts can be found which fulfill them in a given case, belongs exclusively to the particular art or science, or to our knowledge of the particular subject. . . .

"Logic, then, is the science of the operations of the understanding which are subser-

vient to the estimation of evidence; both the process itself of advancing from known truths to unknown, and all other intellectual operations in so far as auxiliary to this.

"Our object, then, will be to attempt a correct analysis of the intellectual process called Reasoning or Inference, and of such other mental operations as are intended to facilitate this: as well as, on the foundation of this analysis, and *pari passu* with it, to bring together or frame a set of rules or canons for testing the sufficiency of any given evidence to prove any given proposition."[1]

Accepting the statement given by Mill as an adequate description of the logical task of estimating evidence, we would also include in the business of logic the collection of evidence, involving the technique of amassing and classifying data and the formulation of explanatory hypotheses. Reasoning as an inquiry leads us into a consideration of the discovery of evidence as well as into an estimation of what has been discovered.

The second trait of reflection is control. As suggestion is the central factor in thinking, the control

[1] *Logic,* pp. 21-23, *passim.*

of suggestion is the central factor in reasoning. Suggestions are the energies of thought. We have already seen that we can not create them. What we can do is to control them. It is regulation and control that transforms loose and random imagination into rational investigation. We may draw an analogy from the mechanical sciences. Science does not create physical energy; it only guides and directs it. The engineer does not create the Mississippi River, what he does is to build levees to direct and control its course. The progress of engineering is a constructive process in which instruments are devised as means of regulating natural energies. In this way we control and use the powers of nature which, left to themselves, threaten to overwhelm us. After the same fashion, we may say that progress in thinking is an engineering process in which invention and construction, devising and planning, ordering and adjusting, are the main factors. We cannot create the stream of thought any more than the engineer creates a river. What we can do is to guide the stream. In emphasizing the factor of control, we define and locate the problem of reasoning. The difference between undisciplined imagination and reflection is describable in terms of the amount

of conscious control we exercise over the flow of our ideas.

Reasoning is systematic inference; the consistent development of meanings and the orderly arrangement of data are brought together into an integrated system. Order, form, coherence, are synonyms for control. "The importance of *connections binding isolated items into a single coherent whole* is embodied in all the phrases that denote the relation of premises and conclusions to each other. (1) The premises are called grounds, foundations, bases, and are said to underlie, uphold, support the conclusion. (2) We 'descend' from the premises to the conclusions, and 'ascend' or 'mount' in the opposite direction—as a river may be continuously traced from source to sea or vice versa. So the conclusion — as the word itself implies — closes, shuts in, locks up together the various factors stated in the premises. We say that the premises 'contain' the conclusion, and that the conclusion 'contains' the premises, thereby marking our sense of the inclusive and comprehensive unity in which the elements of reasoning are bound tightly together. Systematic inference, in short, means the *recognition of definite relations of interdependence between considerations previously unorganized and disconnected, this recognition being brought*

about by the discovery and insertion of new facts and properties."[1]

The third trait of reflection is belief. In imagination suggestions are presented, but they are neither accepted nor rejected on the basis of evidence. The practical test of belief is willingness to act on the suggestion. "Ideas become beliefs only when by precipitating tendencies to action they persuade me that they are signs of things."[2] Now in imagination ideas remain detached from action. They are *mere* visions. And it is conceivable, at least, that the life of the imagination should have remained to the end unrelated to the life of action. But this has not been the case. Suggestion, though idle in the beginning, did not remain so. "Representation, however, can hardly remain idle and merely speculative. To the ideal function of envisaging the absent, memory and reflection will add . . . the practical function of modifying the future. Vital impulse, however, when it is modified by reflection and veers in sympathy with judgments pronounced on the past, is properly called reason."[3] Reflection, then, or as Mr. Santayana calls it, reason, is to be found in the application of

[1] Dewey, *How We Think*, pp. 80-81.
[2] Santayana, *Skepticism and Animal Faith*, p. 16.
[3] Santayana, *Life of Reason*, vol. I, p. 2.

ideas to action. "The Life of Reason is the happy marriage of two elements—impulse (action) and ideation (imagination)—which if wholly divorced would reduce man to a brute or to a maniac. The rational animal is generated by the union of these two monsters. He is constituted by ideas which have ceased to be visionary and actions which have ceased to be vain." [1]

Let us comment further on the topic of belief in the effort to come into closer quarters with the meaning of logical. Beliefs fall into two classes, those which are accepted without evidence, beliefs which are untested; and those which are accepted with evidence, beliefs which are tested. Four types of untested beliefs may be noted.

The first form is *guessing*. To guess is to accept an idea without an investigation of the grounds supporting it. Imagination moves with ease and spontaneity. It is what the mind does naturally and without effort. Reflection requires effort and control. Now guessing is an effort to reap the rewards of reflection while maintaining the ease of imagination. Emerson rightly remarks that to think "is the hardest thing in the world to do." We often, because of sheer mental laziness, prefer to guess and take a chance. No pretext is too

[1] *Ibid,* Vol. I, p. 6.

flimsy and no excuse too lame to offer as makeshifts for intellectual effort.

An easy and uncritical acceptance of beliefs is illustrated in the following quotation from Professor Dewey:

> "If the suggestion that occurs is at once accepted, we have uncritical thinking, the minimum of reflection. To turn the thing over in mind, to reflect, means to hunt for additional evidence, for new data, that will develop the suggestion and will either, as we say, bear it out or else make obvious its absurdity and irrelevance. Given a genuine difficulty and a reasonable amount of analogous experience to draw upon, the difference, *par excellence,* between good and bad thinking is found at this point. The easiest way is to accept any suggestion that seems plausible and thereby bring to an end the condition of mental uneasiness. Reflective thinking is always more or less troublesome because it involves overcoming the inertia that inclines one to accept suggestions at their face value; it involves willingness to endure a condition of mental unrest and disturbance. Reflective thinking, in short, means judgment suspended

during further inquiry; and suspense is likely to be somewhat painful. As we shall see later, the most important factor in the training of good mental habits consists in acquiring the attitude of suspended conclusion, and in mastering the various methods of searching for new materials to corroborate or to refute the first suggestions that occur. To maintain the state of doubt and to carry on systematic and protracted inquiry—these are the essentials of thinking." [1]

In the second place, beliefs are accepted on the basis of *impulse*. The following instructive passage on "The Bias of Impatient Impulse" is well worth consideration:

"As a being formed for action, not only does healthy man take a pleasure in action, physical and mental, for its own sake, irrespective of consequences, but he is so charged with energy that he cannot be comfortable unless it finds a free vent. In proportion to the amount and excitability of his energy, restraint, obstruction, delay is irksome, and soon becomes a positive and intolerable pain. Any bar or impediment that gives us pause is hateful even

[1] *How We Think*, p. 13.

to think of: the mere prospect annoys and worries.

"Hence it arises that belief, a feeling of being prepared for action, a conviction that the way is clear before us for the free exercise of our activities, is a very powerful and exhilarating feeling, as much a necessity of happy existence as action itself. We see this when we consider how depressing and uncomfortable a condition is the opposite state to belief; namely, doubt, perplexity, hesitation, uncertainty as to our course. And realizing this, we see how strong a bias we have in this fact of our nature, this imperious inward necessity for action; how it urges us to act without regard to consequences, and to jump at beliefs without inquiry. For, unless inquiry itself is our business, a self-sufficient occupation, it means delay and obstruction.

"This ultimate fact of our nature, this natural inbred constitutional impatience, explains more than half of the wrong beliefs that we form and persist in. We must have a belief of some kind: we cannot be happy till we get it, and we take up with the first that seems to show the way clear. It may be right or it may be wrong: it is not, of course, necessarily

always wrong; but that, so far as we are concerned, is a matter of accident. The pressing need for a belief of some sort, upon which our energies may proceed in anticipation at least, will not allow us to stop and inquire. Any course that offers a relief from doubt and hesitation, any conviction that lets the will go free, is eagerly embraced. . . .

"This bias works in all men. While there is life, there is pressure from within on belief, tending to push reason aside. The force of pressure, of course, varies with individual temperament, age, and other circumstances. The young are more credulous than the old, as having greater energy they are apt, as Bacon puts it, to be 'carried away by the sanguine element in their temperament.' Shakespeare's Laertes is a study of the impulsive temperament, boldly contrasted with Hamlet, who has more discourse of reason. When Laertes hears that his father has been killed, he hurries home, collects a body of armed sympathisers, bursts into the presence of the king, and threatens with his vengeance — the wrong man. He never pauses to make inquiry; like Hotspur he is 'a wasp-stung and impatient fool'; he must wreak his revenge on somebody

and at once. Hamlet's father also has been murdered, but his reason must be satisfied before he proceeds to revenge and when doubtful proof is offered, he waits for proof more relative."[1]

In the third place, beliefs are accepted on the basis of *emotion.* The reasons we give in explaining our beliefs are rarely the ones that lead us to accept them. The rôle of reflection is too frequently a rational justification of what we have previously accepted on the basis of emotion. Things are said to be logically inconceivable when they are temperamentally intolerable. "The wish is the father of the thought," and "Love is blind," are typical illustrations. Emotional congeniality rather than logical evidence is illustrated in the following passage from Bacon:[2]

"The human understanding resembles not a dry light, but admits a tincture of the will and passions, which generate their own system accordingly; for man always believes more readily that which he prefers. He, therefore, rejects difficulties for want of patience in investigation; sobriety, because it limits his

[1] Minto, *Logic,* pp. 21-23.
[2] Francis Bacon (1561-1626), a British philosopher.

> hope; the depths of nature, from superstition; the light of experiment, from arrogance and pride, lest his mind should appear to be occupied with common and varying objects; paradoxes, from a fear of the opinion of the vulgar; in short, his feelings imbue and corrupt his understanding in innumerable and sometimes imperceptible ways."[1]

In formulating our beliefs the principle of organization is often that of emotional congruity rather than factual connection. Thus Aristotle said that the heavenly bodies move in circles because circular motion was the most perfect motion. And so many of our hypotheses and theories are little more than expressions of esthetic preference and dramatic interest. Philosophers are especially guilty of picturing the world as it ought to be in order to comply with preferred moral and emotional interests. Professor James says that the conflict between materialism and idealism resolves itself into a conflict of esthetic preferences. Spirit sounds noble, elevated, and refined; matter is crass, coarse, and muddy, and since we prefer what is emotionally more satisfying, we declare in favor of idealism. Bacon's denunciation of "anticipations

---

[1] *Novum Organum,* Aphorism XLIX.

of nature" was based on the revolt against the tendency to formulate hypotheses which expressed emotional bias rather than those which were "interpretations" of fact. The tendency is too frequently to set up a theory which is emotionally congenial and then proceed to give out as facts the logical implications of the theory, thus forcing facts to pass under the yoke of theory.

The following quotation from Professor Dewey is instructive:

> "We need to recognize that the ordinary consciousness of the ordinary man left to himself is a creature of desires rather than of intellectual study, inquiry, or speculation. Man ceases to be primarily actuated by hopes and fears, loves and hates, only when subjected to a discipline which is foreign to human nature, which is, from the standpoint of natural man, artificial. Naturally our books, our scientific and philosophical books, are written by men who have subjected themselves in a superior degree to intellectual discipline and culture. Their thoughts are habitually reasonable. They have learned to check their fancies by facts, and to organize their ideas logically rather than emotionally and dramatically.

When they do indulge in reverie and day-dreaming — which is probably more of the time than is conventionally acknowledged — they are aware of what they are doing. They label these excursions, and do not confuse their results with objective experiences. We tend to judge others by ourselves, and because scientific and philosophic books are composed by men in whom the reasonable, logical and objective habit of mind predominates, a similar rationality has been attributed by them to the average and ordinary man. It is then overlooked that both rationality and irrationality are largely irrelevant and episodical in undisciplined human nature; that men are governed by memory rather than by thought, and that memory is not remembering of actual facts, but is association, suggestion, dramatic fancy. The standard used to measure the value of the suggestions that spring up in the mind is not congruity with fact but emotional congeniality. Do they stimulate and reinforce feeling, and fit into the dramatic tale? Are they consonant with the prevailing mood, and can they be rendered into the traditional hopes and fears of the community? If we are willing to take the word dreams with a certain liberality,

it is hardly too much to say that man, save in his occasional times of actual work and struggle, lives in a world of dreams, rather than of facts, and a world of dreams that is organized about desires whose success and frustration form its stuff."[1]

A fourth type of untested beliefs are those accepted on the basis of *authority*. Authority as a source of belief has both a legitimate and illegitimate use. It must of necessity constitute the main source of a student's information. Each of the sciences has a body of definitely ascertained beliefs which constitute the subject-matter of its special concern, and it is the task of the student in acquiring information to become acquainted with this body of beliefs. He has neither the time nor the facility for testing the results of science, results which have been accomplished through prolonged and painstaking research. The molecular theory of heat, for instance, is a well established and scientifically certified belief in physics. The student is presented with it as a basal principle of science; his task is to understand it, not to establish or criticise it.

There is a tendency in modern education to en-

[1] Dewey, *Reconstruction in Philosophy*, pp. 5-7.

courage criticism at the expense of sound scholarship. Students are encouraged to express their own reactions on the assumption that individuality and originality of thought are of prime concern. It is well that students be original; it is better that they be right. Immature and uninformed criticism may easily lead to the formation of superficial habits of reflection. The student's first task is to become acquainted with the basal facts and firmly established principles of science. It is not uncommon to find students in the absence of any authoritative information and in total ignorance of facts, expressing their opinions of matters that lie entirely beyond their comprehension. It is to be feared that our methods of instruction are as much at fault as the student's complacency. The folly of incompetent criticism is well illustrated in the following incident narrated by Plato in the *Republic*.

> "Imagine then a fleet or ship in which there is a captain who is taller and stronger than any of the crew, but he is a little deaf and has a similar infirmity in sight, and his knowledge of navigation is not much better. Now the sailors are quarreling with one another about the steering; every one is of opinion that he ought to steer, though he has

never learned and cannot tell who taught him or when he learned, and will even assert that the art of navigation cannot be taught, and is ready to cut in pieces him who says the contrary. They throng about the captain, and do all they can to make him commit the helm to them; and then, if they fail on some occasion and others prevail, they kill the others and throw them overboard, and having first chained up the noble captain's sense with drink or some narcotic drug, they mutiny and take possession of the ship and make themselves at home with the stores; and thus, eating and drinking, they continue their voyage with such success as might be expected of them. Him who is their partisan and zealous in the design of getting the ship out of the captain's hands into their own, whether by force or persuasion, they compliment with the name of sailor, pilot, able seaman, and abuse the other sort of man and call him a good-for-nothing; but they have not even a notion that the true pilot must pay attention to the year and seasons and sky and stars and winds, and whatever else belongs to his art, if he intends to be really qualified for the command of a ship; at the same time that he must and will be the steerer,

> whether people like him to steer or not; and they think that the combination of this with the art of navigation is impossible. Now in vessels and among sailors, whose condition is such as this, how will the true pilot be regarded? Will he not be called by the mutineers useless, prater, star-gazer?"[1]

On the other hand, the substitution of authority for vigorous individual effort can lead only to indolence and docility. The fallacy of accepting our beliefs on the authority of others has been termed by logicians *argumentum ad verecundiam*. The phrase means the appeal to authority as a substitute for genuine individual thinking. Custom and tradition are closely coupled with authority as sources of untested beliefs. It is not our purpose here to analyze the sources of such untested beliefs, but merely to point out that beliefs accepted on the basis of authority, custom, or tradition are not examples of reflection. Thus writes Hegel: "Think for yourself, is a phrase which people often use as if it had some special significance. The fact is no man can think for another, any more than he can eat or drink for him; and the expression is a pleonasm."[2]

---

[1] Plato, *Republic*, p. 488.
[2] *The Logic of Hegel*, p. 44.

Examine the following passage:

"The improver of natural knowledge absolutely refuses to acknowledge authority, as such. For him, skepticism is the highest duty; blind faith the one unpardonable sin. And it cannot be otherwise, for every great advance in natural knowledge has involved the absolute rejection of authority, the cherishing of the keenest scepticism, the annihilation of the spirit of blind faith; and the most ardent votary of science holds his firmest convictions, not because the men he most venerates hold them, not because their verity is testified by portents and wonders, but because his experience teaches him that whenever he chooses to bring these convictions into contact with their primary source, Nature—whenever he thinks fit to test them by appealing to experiment and to observation—Nature will confirm them. The man of science has learned to believe in justification, not by faith, but by verification." [1]

Although we single out the element of belief as a characteristic trait of reflection, we must be careful to exclude from reflection all thinking involv-

[1] T. H. Huxley, *Methods and Results*, Lecture I.

ing untested beliefs. Genuine reflection is limited to the sphere of tested beliefs. It is thus defined by Professor Dewey: *"Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends, constitutes reflective thought."* [1]

It is, of course, not to be thought that imagination and reflection are mutually exclusive, nor that they define two separate realms of thought. Any specific example of thinking would be classified as one or the other according to the predominance of imaginative or reflective traits. There is usually a minimum of reflection in cases of imaginative thinking and almost always our efforts at serious reflection are impeded by the intrusion of imaginative wanderings. The four types of untested beliefs described above lie on the border line between the two extremes.

3. TRANSITION FROM IMAGINATION TO REFLECTION. The difference between a natural waste and a formal garden is one describable in terms of design, order, arrangement, and purpose. The formal garden is the result of conscious care and deliberate planning; it is a work of cultivation. The landscape gardener does not create any new laws of growth; he merely guides those already in opera-

[1] *How We Think*, p. 6.

tion. His problem is one concerned with the transformation of what already exists. To make the wilderness blossom like the rose is not to superimpose any outside forces; it is to utilize those already existing and by selecting and regulating, by planning and controlling, by ordering and directing, to do by art what nature left to herself would not do.

The analogy may be applied to the cultivation of the mind. While imagination is not reflection, it is the natural basis on which reflection rests. It is what we have to begin with. It is futile to try to superimpose a highly perfected technique of reflection upon an undisciplined imagination. We begin with the natural and spontaneous powers of the imagination and seek to transform *them* into powers of expert and critical inquiry. This means the transformation of natural curiosity, random observation and sporadic suggestion into alert, cautious and thoughtful habits of investigation. All of the processes necessary for reflection are discoverable with the life of spontaneous imagination. It is the business of training to guide these processes effectively, to apply them to serious and important things rather than to dissipate them on trivial and inconsequential matters.

It is regulation which transforms imagination

into reflection. As soon as a child begins to expect, he takes something which is going on as a sign of something to follow. Here we have observation and inference. All that the most highly trained mind can do is to make observations and from these to draw inferences. The trained mind of the specialist differs from that of the child in that it seeks to regulate and safeguard the operations. Observation and inference go on naturally. It is the purpose of the trained thinker to guide the processes effectively; that is, to build up thorough and acute habits of observation and investigation, to regulate the conditions under which ideas are allowed to spring up, to perfect a method of testing them, and to facilitate the technique by which they are applied to the control of affairs.

What, therefore, distinguishes reflection from imagination is not that it employs any radically different processes, but that it takes these processes *in a certain way*. The difference is one of context and of method. When the processes of imagination are taken in a context of inquiry, they assume logical significance. The difference between the logical and the non-logical is in part describable in terms of the context in which the thinking enters. The meaning of logical is also partly characterized by method, that is, by the amount of conscious care that is taken to safeguard thinking against error,

Logical method means that the thought process is regulated and controlled. The thinking is more precise, thorough, exact and accurate.

In the transition from imagination to reflection, we may quote Santayana:

> "In imagination, not in perception, lies the substance of experience, while knowledge and reason are but its chastened and ultimate form. . . .
>
> "It is easy, from the stand-point of acquired practical competence, to deride a merely imaginative life. Derision, however, is not interpretation, and the better method of overcoming erratic ideas is to trace them out dialectically and see if they will not recognize their own fatuity. The most irresponsible vision has certain principles of order and valuation by which it estimates itself; and in these principles the Life of Reason is already broached, however halting may be its development. We should lead ourselves out of our dream, as the Israelites were led out of Egypt, by the promise and eloquence of that dream itself. Otherwise we might kill the goose that lays the golden egg, and by proscribing imagination abolish science." [1]

[1] *Life of Reason,* Vol. I, pp. 53-54.

QUESTIONS AND EXERCISES

1. Give a concrete example of undisciplined imagination, and point out its outstanding traits.
2. Is undisciplined imagination entirely lacking in system and control?
3. Why are we justified in saying that imagination is unrelated to action when as a matter of fact we imagine ourselves doing all sorts of things?
4. When undisciplined imagination is characterized as "native and unlearned," does this mean it is independent of experience?
5. What is meant by characterizing imagination as non-logical?
6. Discuss: "Imagination would prolong itself indefinitely were it not interrupted by a shock from without."
7. Explain the fallacy of hypostatization.
8. Explain the meaning of "I" when you say: "I think."
9. Discuss the following definition of evidence: "Any probative matter serving as a legitimate basis of inference as to the existence of a fact."
10. Are most of our beliefs based on a rational examination of evidence? If not, what factors interfere?
11. Give concrete examples of the four types of untested beliefs.
12. Cite illustrations from literature or history of characters who have a pronounced tendency to accept beliefs on the basis of impulse, or emotion, or authority.
13. Give Minto's definition of belief. How do you think belief should be defined?
14. Explain the Baconian phrases "anticipations of nature" and "interpretations of nature."
15. Explain the fallacy *argumentum ad verecundiam*. Give three illustrations of it.

16. What does Huxley mean by "justification by verification"?

17. When is one rightly entitled to criticise beliefs received on authority? When is one not rightly entitled to do so?

18. Why is the phrase "think for yourself" a pleonasm?

19. Give a concrete example of reflective thinking and point out its logical traits.

20. Examine each of the passages in the chapter in which the term "logical" is used, and with these passages before you state what you think the essential meaning of "logical" to be.

21. How is "scientific" method distinguished from "common sense" method?

22. "The difference (that distinguishes imagination from reflection) is one of context and method." Explain fully.

23. Relate the statement: "Everything ideal has a natural basis and everything natural has an ideal fulfillment" (Santayana) to the interrelation of imagination and reflection.

24. Relate the following statement of Locke to the foregoing question: "God did not make man two-legged and leave it to Aristotle to make him rational."

25. Describe reflection as *chastened* imagination. What forces and factors bring about the chastening?

26. What is meant by saying that the proscription of the imagination would be the abolishment of science?

27. Briefly summarize the topics discussed in the chapter.

CHAPTER THREE

METHOD AND EXAMPLES

1. DESCARTES AND HIS METHOD. In the preceding chapter, the Life of Reason was approached in terms of the distinction between imagination and reflection. Genuine reflection was contrasted not only with loose imaginative wanderings but also with untested beliefs, that is, with beliefs accepted on the basis of impulse, emotion, and authority. As an illustration of the method of reflection we may refer to its employment by René Descartes.[1] In his *Essay on Method,* Descartes tells us something of the history of his intellectual development. The following account is in his own words.

> "I have been nourished on letters since my childhood, and since I was given to believe that by their means a clear and certain knowledge could be obtained of all that is useful in life, I had an extreme desire to acquire instruction. But so soon as I had achieved the

[1] René Descartes (1596-1650), a French philosopher.

entire course of study at the close of which one is usually received into the ranks of the learned, I entirely changed my opinion. For I found myself embarrassed with so many doubts and errors that it seemed to me that the effort to instruct myself had no effect other than the increasing discovery of my own ignorance. And yet I was studying at one of the most celebrated schools in Europe, where I thought that there must be men of learning if they were to be found anywhere in the world. I learned there all that others learned; and not being satisfied with the sciences that we were taught, I even read through all the books which fell into my hands, treating of what is considered most curious and rare. Along with this I knew the judgments that others had formed of me, and I did not deem that I was esteemed inferior to my fellow-students, although there were amongst them some destined to fill the places of our masters. And finally our century seemed to me as flourishing, and as fertile in great minds as any which had preceded. And this made me take the liberty of judging all others by myself and of coming to the conclusion that there was no

learning in the world such as I was formerly led to believe it to be."[1]

Descartes, then, had gone through the university and had learned everything which it had to teach. But he had accepted all of his beliefs on the basis of authority. He really did not know "why" he believed anything. The information which he had acquired through his studies and his readings constituted a somewhat burdensome body of untested beliefs. Although preserving an affection for his old teachers, Descartes left school with a restless and unsatisfied mind. He first resolved that he would gain some experience of the world, and accordingly joined the army, with the interest, however, of a tourist rather than that of a soldier. "But after," he says, "I had employed several years in thus studying the book of the world and trying to acquire some experience, I one day formed the resolution of also making myself an object of study and of employing all the strength of my mind in choosing the road I should follow."[2]

Accordingly, Descartes undertook to think out for himself a body of beliefs which he could accept.

---

[1] *The Philosophical Works of Descartes,* ed. by Haldane and Ross, Vol. I, pp. 83-4.

[2] *Ibid.,* p. 87.

As a general method he decided that he would doubt the truth of everything which he had hitherto believed. He says of himself: "But as regards all the opinions which up to this time I had embraced, I thought I could not do better than endeavor once for all to sweep them completely away, so that they might later on be replaced, either by others which were better, or by the same, when I had made them conform to the uniformity of a rational scheme."[1] Descartes did not doubt out of a wilful spirit to disbelieve; he doubted in order to put his beliefs to a rational test. His purpose was to put reflection in the place of tradition and authority.

It is beyond the limits of the present inquiry to attempt a statement of the body of beliefs which Descartes ended by constructing. Such a statement would be included in the history of philosophy. Descartes is of interest to the logician because of the special method which he employed in his search for truth. What he achieved as the result of his effort he attributed to the significance of his method. The following is Descartes' account of the four steps involved in his method:

"I believed that I should find the four

---

[1] *Ibid.*, p. 89.

which I shall state quite sufficient, provided that I adhered to a firm and constant resolve never on any single occasion to fail in their observance.

"The first of these was to accept nothing as true which I did not clearly recognize to be so; that is to say, carefully to avoid precipitation and prejudice in judgments, and to accept in them nothing more than what was presented to my mind so clearly and distinctly that I could have no occasion to doubt it.

"The second was to divide up each of the difficulties which I examined into as many parts as possible, and as seemed requisite in order that it might be resolved in the best manner possible.

"The third was to carry on my reflections in due order, commencing with objects that were the most simple and easy to understand, in order to rise little by little, or by degrees, to knowledge of the most complex, assuming an order, even if a fictitious one, among those which do not follow a natural sequence relatively to one another.

"The last was in all cases to make enumerations so complete and reviews so general that

I should be certain of having omitted nothing."[1]

The first rule states the belief that any mind is competent to grasp the truth. It is designed to beget in each of us confidence in our own thinking. For example, let us say, the book is on the table. This is a fact of perception. Now Descartes admits that it might be possible to doubt this fact. There may be some question as to whether it really is a book. It may be that what I think I see is only an optical illusion. It would, therefore, require some corrective operation to verify the accuracy of my perception. The perception, just as it occurs, does not contain within itself the guarantee of its validity, and so is not immediately certain. And then there is no dearth of skeptics to say that the table is not an objective and independent reality, but is a group of sensations, each varying with different observers and varying for the same observer with different points of view. Now Descartes was much more certain of the things of his mind than he was of the perceptions of his body. As an illustration of this kind of knowledge, let us say that if there is such a thing as a book, if there is such a thing as

[1] *Ibid.*, p. 92.

a table, and if the book is on the table, then it cannot at the same time be off the table. Now this proposition I see clearly and no skeptic can possibly confute it. Of two contradictory propositions, one must of necessity be true and the other false. To deny such a proposition would make maniacs of us all. To accept such a proposition as true requires nothing more than the immediate deliverance of my own mind. I do not need any one else to tell me that it is true. I do not need the assent of other minds to the proposition. It is what I cannot help believing. Good sense is the name which Descartes gives to this kind of intellectual apprehension, and he says that of all things it is the most widely distributed among mankind. One person has just as much of it as another. Such knowledge is enveloped in the natural light of the mind, and is as clear and as certain as lucidity itself. Now in acquiring any body of beliefs Descartes thinks it is important to accept nothing as true which we do not grasp with equal clearness and distinctness.

The second rule emphasizes the importance of analysis. The most difficult problems can be solved by breaking them up into parts, and by attending to the parts separately. The importance of this step will be fully considered in the sequel.

The third rule pertains to the starting point of reflection. Every chain of reasoning should have as its first link one which is simple and fully understood. If we are careful to guard the beginnings of our thinking the endings will more or less take care of themselves. Students in their academic careers are continually launching out into new fields of inquiry. They are given conclusions in the form of accepted generalizations but with little knowledge of the foundations on which those results are grounded. In expounding the significance of Descartes' third rule, we may call Plato to our assistance. In a passage in which he is discussing the progress of the mind in its appreciation of art, he says:

> "For he who would proceed rightly in this matter should begin in youth to turn to beautiful forms; and first, if his instructor guide him rightly, he should learn to love one such form only—out of that he should create fair thoughts; and soon he will himself perceive that the beauty of one form is truly related to the beauty of another; and then if beauty in general is his pursuit, how foolish would he be not to recognize that the beauty of every form is one and the same! . . . This will

lead him on to consider that the beauty of the mind is more honorable than the beauty of the outward form. (And from this he will be led on) to see the beauty of institutions and laws . . .; and after laws and institutions he will lead him on to the sciences, that he may see their beauty . . . until at length he grows and waxes strong, and at last the vision is revealed to him of a single science, which is the science of beauty everywhere. . . . And the true order of going, of being led by another, of the things of beauty, is to use the beauties of earth as steps along which he mounts upwards for the sake of that other beauty, going from one to two, and from two to all fair forms, and from fair forms to fair actions, and from fair actions to fair notions, until from fair notions he arrives at the notion of absolute beauty, and at last knows what the essence of beauty is."[1]

Education in esthetic appreciation begins with direct and full appreciation of some one object of art. There is no appeal beyond the immediacy of one's spontaneous enjoyment. Then when we see another object of art, we see for ourselves that the beauty of the second is related to the beauty of the

[1] *Symposium*, p. 210.

first. The sphere of appreciation widens, not so much by the appearance of new objects as by the recognition of their esthetic relation to what we already enjoy.

The method for increasing our capacity for the appreciation of art is applicable to the growth of knowledge. We begin with some one proposition which is simple, clear and distinct, and with that as an ever widening center make additions by accretion. It should also be noted that the words "assuming an order, even if a fictitious one," *etc.,* recognize the place of "hypothesis" in reflection, an important concept which will be further analyzed in what is to follow.

The fourth and last rule emphasizes the importance of synthesis. By means of complete enumeration and general review one sees the parts of a problem in their interrelation.

The four points of Descartes' *method* might well be used as guiding principles in the investigation of any new subject. They should prove of especial value to the student who first undertakes to investigate the logic of reflection.

2. EXAMPLE OF REFLECTION. Having marked off the field of reflection as the province of logic, we are now ready to proceed with an analysis of the logic of reflection. As an approach to such an

analysis, let us begin with an illustration, being careful to select one which is simple enough to contain nothing which is not clearly and distinctly understood, thus observing the first rule of Descartes' method. Take for example the following:

——weather——has a——effect on——spirits.

Suppose we are asked to fill in the blank spaces in such a way as to make a complete sentence.

I look carefully at each of these words to see what it is and to be sure that I have read it correctly. Each word separately and in its relation to the whole group suggests possible words to insert in the gaps. I have in my mind various kinds of weather which are at once suggested when I see the word "weather." I think of clear, bright, cloudy, rainy, *etc.* I also think of the different kinds of effects that various types of weather produce on one's spirits. Then out of the variety of suggested words, I select the ones which seem best suited to render a coherent meaning to the sentence as a whole. As a result I conclude: Clear weather usually has a pleasing effect on one's spirits.

Let us now analyze the operation we have just performed in order to see precisely what it is we have done and what steps we have taken. It is easy to distinguish three quite distinct phases. First, there is the statement of a problem. We are

given an incomplete list of words and gaps which just as they stand do not make sense. We are asked to reconstruct the sentence in a way which will make it intelligible. Secondly, there is the search for the missing words, some brief consideration of each, and a selection made on the basis of the fitness of each to render the meaning as a whole consistent. In the third place, there is the finished product, the reconstructed sentence, the final interpretation.

Now where does thinking come in? Not in the first stage. The words and gaps are observed. There is just seeing and reading, but seeing and reading of such a nature as to pose a problem. The thinking comes in the second stage and occupies a position in between the start and the finish. One had to think in order to discover the missing words and to select the ones best suited to bring out a coherent meaning. This thinking was based on a careful noting of just what words were given. The words which were given suggested others, and the ones suggested were considered in their relation to the ones given. This intermediary process contains two sub-divisions. (1) Data and meaning: The data are what we have to begin with, the facts in hand. They are the words and gaps of the original group. The meanings are what these words

suggest. Together they constitute the materials and resources with which thought sets to work. It requires no reflection to ascertain the data beyond a careful noting of what they are. The meanings which are brought to bear as interpretative material come through the natural channels of suggestion. (2) Reasoning: Each of the suggested words is examined and some consideration given to the reasons for accepting or rejecting it. The meanings suggested are developed with reference to their adaptability to fit into a complete sentence. This operation is termed reasoning and consists in an examination of the evidence supporting a choice. The process terminates in judgment, that is, a decision to accept a given word. The third stage expresses the result accomplished. We end with a solution, whereas we began with a problem.

We may express the results of the foregoing analysis in the form of a diagram:

Starting point	*Intermediary*	*Finishing point*
Words and gaps	Search for words	Completed sentence
Problem	Investigation	Solution
Complication	Development	Resolution
Perception	Thinking	Knowledge
	1. Data and meaning	
	2. Reasoning	

Reflection on the foregoing yields the following observations. First, thinking begins with a problem. A mutilated sentence is mystifying. There is something puzzling about disconnected words. It is the absence of what we expect that starts us to thinking. We think because there is something there to think about. Thought takes its rise in a situation where there is something left out, where there is a gap that needs to be bridged. In the second place, thinking occupies an intermediary position, a position which is secondary and derivative. In the language of Professor Dewey, "It comes after something and out of something, and for the sake of something."[1] The temporal placing of thought as an intervening operation is a fact of the utmost significance. Its function and its validity will have to be judged in terms of its position. In the third place, the function of thought is instrumental. Thinking plays a rôle and subserves a purpose. We must be careful to distinguish between the purpose which I have in thinking and the purpose which thought serves in the context in which it operates. My purpose in thinking may have been to satisfy my curiosity or to win a prize for the best answer to the above problem. But the thinking which I do has as *its*

[1] *Essays in Experimental Logic,* p. 75.

purpose the specific aim of solving the problem. Fourth, the outcome and result of thinking, its objective, is knowledge. I now *know* what the sentence means.

QUESTIONS AND EXERCISES

1. Do you think that Descartes' description of his university experience is characteristic of the modern student?

2. What were Descartes' four principles for the determination of valid knowledge? What is the meaning of each for reflection?

3. Do you consider Descartes' standard of "clearness and distinctness" as a valid principle for the determination of truth?

4. What are some of the considerations which led Descartes to doubt the evidence of the senses?

5. As Russell has adapted Descartes' method to his own use, it can be stated as "a passage from the uncertain and inexact, through the certain and inexact, to the certain and exact." Explain.

6. Analyze an original problem as it has actually occurred, distinguishing the three steps, and showing how the whole thought situation is placed in a background of undisciplined imagination.

7. What characteristic do you find common to undisciplined imagination and reflective thinking?

8. Enumerate the respects in which reflective thinking differs from undisciplined imagination.

9. What two outstanding elements are distinguishable the moment we begin to analyze a problem?

10. The distinction between data and meaning is one of the most important that the student has to grasp. Special care should be taken to make the distinction clear and distinct. To

that end, formulate a definition of datum and of meaning. Cite examples to illustrate the operation of both factors in reflection. By what processes are the two factors apprehended? Distinguish the phase in reflection characterized by the ascertainment of data and meaning from the more advanced phase of reasoning.

11. What is the total outcome of a problem situation (1) as to the character of belief; and (2) as to the condition of the mind?

12. Explain each of the four observations made in the closing paragraph of the chapter.

CHAPTER FOUR

THE STARTING POINT

The Life of Reason, according to Mr. Santayana, represents the fusion of the life of the imagination and the life of action. To live either of these lives in total separation from the other would be to reduce one to a "maniac" or to a "brute." Ideas unrelated to action or unchecked by experiment are inchoate and unsubstantial; actions unguided by ideas are blind and often futile. Accordingly, the life of reason may be approached from the standpoint of imagination or from the standpoint of action. We may observe the method by means of which "ideas cease to be visionary" or we may observe the procedure by means of which "action ceases to be vain." In the one case reason expresses the discipline of the imagination; in the other it represents the controlled character of experience and action. These two approaches would represent, respectively, the standpoints of introspective and behavioristic psychology. In Chapter Two the approach was made

from the standpoint of introspective analysis. The distinction was made between two kinds of thinking, namely, undisciplined imagination and reflection. Reflection, it was said, was secondary to the imagination and was but its ultimate and chastened form.

1. Two Kinds of Experience. In the present chapter the approach to the analysis of reflection will be made from the standpoint of action and experience. This is entirely legitimate since the distinctions of reflection are equally applicable to the analysis of behavior. We say, for example, "That was an unwise thing to *do*," or "He *acted* very intelligently," thus indicating two kinds of activity. We may, therefore, distinguish two types of experience, reflective and non-reflective. This distinction may also be expressed as cognitive and non-cognitive, or as logical and non-logical.

Reflective experience involves thinking which is critical and consciously purposeful, thinking which terminates in belief, which is possessed of logical significance, and which may be termed essentially a knowing. Deliberative inquiry, practical investigation and scientific research are synonyms of reflection. But just as investigation and inquiry do not exhaust the possibilities of experience, so reflection is not coextensive with human activity. There

is much in experience which is of no cognitive significance, and which is entirely devoid of logical properties. Any one may distinguish between the act of picking up a glass of water and drinking it when one is thirsty and the act of reflecting upon water when the aim is to determine its properties. The former act is primarily concerned with action and moves in the realm of being; the latter is essentially a matter of reflection and moves in the realm of knowing. We here hit upon a most important philosophical distinction, that between action and being on the one hand, and reflection and knowing on the other.

The life of reason is secondary to the life of action. Water exists primarily to be drunk not to be thought about. Man is essentially a creature of action, and only secondarily a creature of reflection. Reflection emerges in the course of man's progressive struggle to gain control over his environment. So long as things adequately serve our purposes we use them rather than think about them. It is only when their uses are insufficient that they become objects of thought. The time when I think most about my hat is when I have lost it.

Let us now briefly characterize the type of experience which is non-reflective, that is, the kind of experience which goes on prior to the superven-

tion of cognition. An illustration will best serve our purpose. I may rise in the morning, dress, have breakfast, take a trolley to the office, and begin the routine of the day, all within the sphere of non-reflective activity. Impulse, habit, feeling, prior intellectual elements are integrated into an organized unity of action. There is no question of impulse, habit, and feeling; they are of undoubted non-logical status. But how about the intellectual elements in the action? Certainly I "know" the way to the office, I "know" what car to take. Is not this reflection? Knowledge of this kind is present in all experience. It represents the outcome of past intellectual effort. Though such knowledge is present in all experience, it is not present in such a way as to give the experience its dominant feature. Mere presence in experience of meaning is not enough to give to the experience the character of reflection. The results of past knowledge operate as factors of unity and order. They function as present or immediate values. They are used as means of unified action and not as elements in an investigation. The action above described contains no logical properties. Past meanings function logically when they are taken in a context of inquiry and are used as agencies in an investigation. Unified action knows no distinc-

tion between data and meaning. The factual elements in the situation do not stand out *as* discriminated elements and the meanings do not emerge *as* conscious agencies in the direction of activity.

The outstanding trait of non-reflective experience is unity. Each element in the series of concatenated action follows in a succession of uninterrupted transitions. The facts are perceived without question, the meanings are appreciated without effort, and the action advances without delay. The experience as a whole is an organized synthesis. That is to say, the action antedates analysis, and what is the same thing, the distinction between data and meaning is not yet made, there being no reason why such a distinction should be made.

But such a situation may, at any moment, give rise to reflection. Suppose, for example, that on my way to the office the usual car does not come. Here is an interruption which causes a break in the unity of action. I then begin to think of some other way of getting to the office. The data and meanings which are in suspense in the customary routine of going to the office now emerge as conscious factors. The distance to the office, the character of the street, the kind of weather, are facts which now become objects of special consideration. The

distance means that I cannot walk it in twenty minutes and I am due there in that time. The corner where I am is near a drug store. This means that I can telephone for a taxi. The situation is resolved into data and meaning and these cooperative factors are utilized as resources of reflection. The facts, instead of being mere facts of perception, are used as bases of inference. The meanings, instead of being mere objects of appreciation, are used as instruments of reflection.

2. THE ORIGIN OF REFLECTION. It is true that we are more interested in understanding the operation of intelligence than we are in disclosing its origin. Nevertheless, a knowledge of its origin is necessary both to an understanding of the function of intelligence and to an estimation of its validity. Thinking has its antecedents in a situation of prior non-reflective experience. While this antecedent situation is not reflection, it is the kind of situation which may with the slightest shock glide into reflection. When the original unity of experience is broken, when there is an interruption, when something goes wrong, thinking emerges and has as its specific function the restoration of unity. Its value, therefore, is to be judged by the success which thought has in accomplishing its end.

So long as things flow along in their customary

channels, so long as our habitual ways of doing things are sufficient to meet the practical demands of life, there is no need for thought. As long as we do the same thing over and over in the same way, action becomes a matter of routine and habit. It is when an unexpected situation arises for which we have no ready-made rule of thumb which can automatically apply that we begin to think. Uncertainty, confusion, doubt, hesitancy are the sources from which thinking takes its start and the spurs that urge us forward to reflection. Using the word "problem" in a broad sense to cover any kind of situation that involves an emergency, we may say that the thinking process is a problem-solving process. The essential meaning of a problem is to be found in the fact that some end or purpose we have in mind is temporarily thwarted. Things get in the way and interfere with our plans, obstructing our actions and blocking our desires. Something flies up, and, as we say, hits us in the face. Why? What's that? What is the matter? What shall I do? Situations that force such questions are problematic situations. As defined by Professor Woodworth: "A 'problem' is a situation for which we have no ready and successful response. We can not successfully respond by instinct or by previously acquired habit. We must

find out what to do." Given a problem as the starting-point, some sort of thinking inevitably follows. The circumstances of life demand that problems be got over in order that normal activity may proceed. Furthermore, the mind is naturally hostile to problems. So long as we are confronted with an unsolved difficulty, we are in a state of emotional unrest.

Following the analysis made by Professor Dewey, we may say that reflection has its origin in a situation involving the breakdown of habit and the reorganization of activity around impulse as a pivot. A full understanding of this analysis will involve some account of instinct and habit in their relation to reflection. The phrase, "the breakdown of habit," needs some explanation. It is not so much that habits themselves break down as that a new situation arises to which existing habits are inadequate to respond. For instance, one who is accustomed to driving an automobile may be suddenly called on to drive an airplane. When confronted with this new problem, it is not that the automobile habits break down, but that they are insufficient for the successful accomplishment of the new task. A child, for example, observes for the first time the falling of autumn leaves, and asks for a reason. This phenomenon lies outside the child's

customary habits of observation. His previously formed ways of looking at things do not account for this deviation in the behavior of the leaves which the child has always observed on trees and not falling from them.

That reflection has its origin in a situation characterized by the breakdown of habit seems obvious enough. But that the progress of reflection involves the reorganization of activity around impulse as a center is a conception which is somewhat more difficult to grasp. In the preceding analysis of reflection made from the standpoint of two kinds of thinking, it was observed that reflection was not a force that came into experience from without, but was rather to be accounted for by taking imagination as a natural basis and transforming it into reflection. The same general point of view is to be held in the analysis of reflection from the standpoint of the distinction between two kinds of action. It is also true here that reflection does not enter experience as through a door from without. Reflection has a natural basis, a working foothold within the sphere of action. From this standpoint the natural basis of reflection is impulse. Reflection is not a kind of activity totally different from impulse and habit but rather represents impulse clothed and in its right mind.

If man had no natural resources other than habit, he would, when habits break down, stare vacantly in the face of disaster. But fortunately he does have other resources. A man's automobile driving habits may be insufficient for the piloting of an airplane, but nevertheless, prompted by the impulse to experiment with the novel, a new beginning is made in terms of trial and error. The child's intellectual habits may be insufficient for interpreting the novel phenomenon of falling leaves, but an incipient intellectual advance is made in the assertion of the instinct of curiosity. The breakdown of habit, therefore, does not mean the total cessation of activity. The on-going urge of impulse provides an initial impetus for a new trial.

The life of reflection is, therefore, secondary to the life of action. Man is primarily a creature of impulse. We may cite the following quotation from Professor James:

> "The cat runs after the mouse, runs or shows fight before the dog, avoids falling from walls and trees, shuns fire and water, etc., not because he has any notion either of life or death, or of self-preservation. He has probably attained to no one of these conceptions in such

a way as to react definitely upon it. He acts in each case separately, and simply because he cannot help it; being so framed that when that particular running thing called a mouse appears in his field of vision he *must* pursue; that when that particular barking and obstreperous thing called a dog appears there he *must retire,* if at a distance, and scratch if close by; that he *must* withdraw his feet from water, and his face from flame."[1]

As a description of the meaning of instinct, we may quote Mr. Ginzberg. "Accordingly we mean by the term instinctive activity to indicate certain more or less complicated trains of movement which are adapted to certain ends useful to the race, which are congenitally determined and are independent of previous experience by the individual organism."[2] These unlearned and inborn capacities for action are extremely modified, and seldom remain in their original state. In their native form they are little more than empty content which gets its filling from the interaction of the organism wih its environment. Our original nature does not persist unchanged; it is transformed into an

---

[1] *Psychology,* Vol. II, p. 384.
[2] *The Psychology of Society,* p. 1.

acquired nature. Flexible impulse gets its set in habit.

For a characterization of habit we may turn to Professor Dewey. "But we need a word to express that kind of human activity which is influenced by prior activity and in that sense acquired; which contains within itself a certain ordering or systematization of minor elements of action; which is projective, dynamic in quality, ready for overt manifestation; and which is operative in some subdued subordinate form even when not obviously dominating activity. Habit even in its ordinary usage comes nearer to denoting these facts than any other word." [1] In this we see that impulse is taken up and incorporated into habit. Habit takes over from impulse its propulsiveness and its power while at the same time acquiring in its own right definiteness and direction. It is thus that habit is so competent an expression of the activities of men. Character, according to Professor Dewey, is the interpenetration of habit. The kind of person we are at any time depends on our habit-organizations, and the way these organizations are interrelated. "The self that a man exhibits and of which he is conscious, at any given period of his life, depends

---

[1] *Human Nature and Conduct,* pp. 40-41.

on the complex system of habits he has in the course of his experience developed."[1] It is thus that one may give himself away in a look.

The self which is formed through the interpenetration of habits is exceedingly unstable. Habits are at the mercy of the forces which produced them. As they owe their existence to experience, by experience they may also be disrupted. When a new situation arises for which no adequate response is found among the resources of habit, the self disintegrates. The unity and organization characteristic of habit is severed. In our confusion, we go all to pieces, as we say. Now what we do in such cases is to pull ourselves together. Habits are means of control. Their disintegration means not only that we lose grip on the situation; we also lose grip on ourselves. If the self is the system of organized habits, the disruption of that system means the disruption of the self. In the suddenness of the shock we do not know who we are, or where we are, or what we are. In losing control of the situation, we also lose ourselves. In the street car illustration, for example, I am, during my moments of reflection, only a potential self; I am a self who *may* go to the office in a taxi, or

[1] Edman, *Human Traits*, p. 152.

who *may* walk, or who *may* not go at all. Now what I must do is to recover myself.

Fortunately, we have within ourselves resources for such an undertaking. While habit builds on impulse, it never exhausts the native supply. There is always enough left to serve as a nucleus for reorganization. In training a hunting dog to retrieve, for instance, the moment the dog loses his signal his actions cease to conform to incipient habit. The animal reverts to impulse and goes sniffing around in a vain and futile manner, exhibiting the hunting instinct in its native and untrained expression. Men do not differ from the animals in that they have no impulsive nature to fall back on. They differ in that they have a reflective nature by means of which they may reorganize their activity around impulse as a pivot. When, for example, your automobile suddenly comes to a stop and you do not know what is the matter you get out and poke around trying first one thing and then another in the hope of locating the difficulty. You utilize an impulse for an end beyond itself. A young man in search of a position thus describes an interview with the managing director of a large business concern: "I called on Mr. X and he positively insulted me. When I entered his office he asked me to sit down while he finished a letter.

After about five minutes he jumped suddenly from his chair, walked toward me, and banging his fist with great vigor on a table near me, shouted: 'What the devil do you know about business?' At first I was so unnerved that I could not even collect my thoughts and I was so flurried that I could not answer his further questions. I was upset by his sudden attack as I had not expected to be treated in such a way. In a few moments, however, I became indignant, and under the influence of my indignation, I recovered myself. I informed him that I could not permit him to speak to me in such a manner. As it turned out, the director was only testing me as he wished to discover my manner of dealing with an unexpected situation." In this incident the self of ordinary interviews goes to pieces in the face of the unexpected. In the breakdown of habit, the primary impulse to resent an insult asserted itself. The self which took further part in the conversation was completely reorganized around this impulse as a center.

Enough, we trust, has been said in explanation of the statement that reflection originates in a situation characterized by the break-down of habit and the reorganization of activity around some impulse as a center. If we will take the trouble to trace out the antecedents of the word "that" when we say:

"That started me to thinking," we will find them to consist in a type of experience in which there is disintegrating habit and incipient confusion.

3. DATA AND MEANING. The outstanding feature of reflection is to be found in the distinction between data and meaning. The original unity characteristic of non-reflective experience is severed into something given and something sought. Let us take an ultra simple illustration. Suppose I have lost my hat. Of course I may resort to trial and error, looking first in one place and then in another, without effort to discriminate. But such a procedure would be unintelligent. Instead, I make a conscious effort to control the search. My procedure in this case is to resolve the gross total situation into elements and to use these elements as a basis of inquiry. What are the facts? That is, where am I? Where was I when I lost my hat? Where have I been in the meantime? The situation is analyzed into data and this is done in order that thought may have a definite point of departure. Data constitute one type of factor. The other is meaning, the body of intellectual content with which I approach the problem. The analysis of the situation into two factors is made in order that reflection may have something to work on. The getting of each factor is a work of thought.

I had to think in order to recall the places where I had been in the meantime and I had to think in order to bring fruitful interpretative and conceptual material to bear.

Consider the following quotation from Hobbes as descriptive of the same procedure:

> "In sum, the discourse of the mind, when it is governed by design, is nothing but *seeking*, or the faculty of invention, . . . a hunting out of the causes of some effect, present or past; or of the effects of some present or past cause. Sometimes a man seeks what he hath lost; and from that place and time wherein he misses it, his mind runs back from place to place, and time to time, to find where and when he had it; that is to say, to find some certain and limited time and place, in which to begin a method of seeking. Again, from thence his thoughts run over the same places and times, to find what action or other occasion might make him lose it."[1]

One may readily recognize the part played by both data and meaning in the above description. The distinction is made in order that thought may have a working foothold. The distinction

---

[1] Rand, *Modern Classical Philosophers*, p. 66.

yields both the materials and the means of reflection. And it is important to note that the distinction is one that falls well within the thought process. To quote Professor Dewey:

> "A distinction which is made within the thought process as a part of and for the sake of its own *modus operandi*."[1] "In other words, both datum and ideatum are divisions of labor, cooperative instrumentalities for the economical dealing with the problem of the maintenance of the integrity of experience."[2] "What is insisted upon is the relative, instrumental, or working character of the distinction—that it *is* a *logical* distinction, instituted and maintained in the interest of intelligence, with all that intelligence imports in the exercise of life functions."[3]

4. STATEMENT OF THE PROBLEM. Given a problem, which is the condition of there being any thinking at all, the first thing one does is to get the problem definitely formulated. Thinking is effective just to the extent that it is based on a clear and firm grasp of what the difficulty is. The compet-

---

[1] Dewey, *Essays in Experimental Logic*, p. 104.
[2] *Ibid.*, p. 140.
[3] *Ibid.*, p. 237.

ence or incompetence of a final judgment will depend to a large extent on the way in which a preliminary survey of facts is made. The problem is what we begin with, and if we have no clear idea of the starting-point, there can be little hope of a satisfactory finish. Definite knowledge of what is wrong is an indispensable prerequisite to setting things right. Most confused thinking is due to a confused understanding of the problem with which we are confronted. Our efforts are dispersed and our attention distracted because we do not take the trouble to discover the exact nature of the difficulty. Most problems first present themselves in a vague and undefined manner. There may be little more than just the uneasy feeling that something is wrong, or the uncanny premonition that things are not going as well as they might be. In other cases we feel that some drastic measure must be taken, but the difficulty is too dispersed, the ends and means too remote and obscure to be of any service as a basis for the determination of a course of procedure. What is needed is analysis and clarification. Often when thinking is confused it is because there is no clear-cut and precise statement of the subject of thought.

Defining, locating and formulating the problem corresponds to what in the practice of medicine is called diagnosis. Before attempting to treat a

disease the physician first ascertains the exact nature of the trouble. It is also analogous to what in debating is called defining the issue.

The execution of this step involves the resolution of the problem into data and meanings, into a statement of what is there and an appreciation of the bearings and significance of the facts noted. Once a problem is properly placed in a fruitful context, it more or less solves itself. The really difficult thing is to know what contacts and analogies, what facts and principles, what data and meanings to take as basal points of reference. In the case of children, once they are given a hint or clue, they follow it up and find the answer for themselves. But in individual thinking, we have to find the clue for ourselves. To quote Professor Creighton:

> "It is essential to have ('in order to determine as accurately as possible the nature of the starting-point') a full and accurate survey of the terms of the problem, and to note carefully every clue that may lead to a solution."[1]

These two operations are precisely what we mean by data and meaning. We may now proceed to treat each separately and in greater detail.

---

[1] *Logic*, p. 208.

QUESTIONS

1. Show how the distinction between imagination and reflection on the one hand, and the distinction between non-reflective and reflective experience on the other, represent approaches to the life of reason from the standpoint of ideation and action, respectively.

2. How are the two types of approach stated above to be reconciled?

3. In what respect can undisciplined imagination be correlated with non-reflective experience? In what respects not? Answer the same questions for reflective thinking and reflective experience.

4. What are the impelling and controlling elements in non-reflective experience? Show how each of these elements is void of logical properties. Explain the meaning of "logical" in this connection.

5. What in particular is meant by the "intellectual element" in non-reflective experience? In what sense is it of no logical significance?

6. Explain fully the meaning of "unity" as applied to non-reflective experience.

7. State Dewey's characterization of the origin of reflection.

8. Define the meaning of "problem."

9. Give a full discussion of the relation of habit to reflection.

10. Give a full discussion of the relation of impulse to reflection.

11. Contrast the method of reflection with that of trial and error. Is trial and error entirely absent from reflection?

12. Explain the statement that the distinction between data and meaning is the characteristic trait of reflection.

13. What is meant by saying that the distinction between

data and meaning is a logical distinction? What is meant by "logical"?

14. What purpose does the distinction between data and meaning subserve in reflection?

15. What is the first step to be taken in the solution of a problem?

16. What is the significance of the statement: "A problem which is well defined is half solved"?

ILLUSTRATIONS

1. Give an example of non-reflective experience, and point out its chief traits.

2. Give an example of reflective experience, and point out its chief traits.

3. Write a paper illustrating the manner in which reflective experience has its origin in non-reflective experience.

4. Give an illustration to show that the self of reflection is a number of potential selves.

5. Give an example illustrating the statement that character is the interpenetration of habit.

6. Give an illustration to show the function of impulse as a pivot for reorganization.

7. Illustrate the distinction between data and meaning as a distinction falling within the thought process.

EXERCISES

1. Work out your own answer to the statement that the validity of thought cannot be considered independently of its origin.

2. In the illustration cited from Hobbes (p. 108) what factors are data and what ones are meanings?

3. Relate the discussion of personality given in the present chapter to the discussion given on p. 48.

4. Relate the statement that the distinction between data and meaning is the characteristic mark of reflection with the statement on p. 50, that the characteristic features of reflection are the examination of evidence and the operation of belief.

5. Examine the passages in this chapter in which the word "logical" is used. Relate your answer to this question with the answers given to question 20, p. 75.

6. Can thinking go on in terms of data alone? Reasons for your answer.

7. Before advancing in your reading, state the topics which you think need further discussion, and state the order in which you think they should be discussed.

CHAPTER FIVE

DATA

1. The Rôle of Data. In almost any inquiry, the first question we ask is: What are the facts? The facts do not constitute the starting-point of reflection. Thinking begins with a problem. We adduce facts as a means to its solution. Data are given *in* reflection, not to it. That is to say, the analysis of a prior non-reflective situation into what is given is itself a work, and a very genuine work of thought. The noting of facts, the enumeration of instances, the collection of data, is not a pre-inductive operation; it is an integral part of inductive procedure and falls well within the thought movement.

Of course in a sense the data were there prior to their analysis, but they were not there as they are when taken in a cognitive context. They were not there as stepping-stones for the advance of thought; they were not there as discriminated elements to be taken account of in inquiry; they were not there as logical elements, that is, as signs indicating other

existences; they were not there as *significant* facts, as *crucial* instances, as *relevant* data. To quote Professor Dewey:

> "To find out *what is* given is an inquiry which taxes reflection to the uttermost. Every important advance in scientific method means better agencies, more skillful technique for simply detaching and describing what is barely there, or given. To be able to find out what can safely be taken as *there,* as given in any particular inquiry, and hence be taken as material for orderly and verifiable inference, for fruitful hypothesis-making, for entertaining of explanatory and interpretative ideas, is one phase of the effort of systematic inquiry. It marks the inductive phase."[1]

This means that data are possessed of logical significance. As signs indicating other existences, they function as means to knowing. For example, I know John by his walk. The walk is a trait analyzed out and used as a means of knowing. "By their fruits ye shall know them." 'Walks' and 'fruits' are things we know with. Data as well as meanings are instrumentalities of knowing. They

[1] *Essays in Experimental Logic,* p. 104.

constitute the natural factors in terms of which knowing goes on, thus affording for reflection a material basis of continuity with the natural order in which thinking functions as a means of control. Data, therefore, are not things about which we think, they are the things we think with; they are logical materials, a necessary part of the warp and woof of thought's texture. To quote Professor Dewey again:

> "It is by the color stain that we know a cellular structure; it is by marks on a page that we know what some man believes; it is by the height of the barometer that we know the probability of rain; it is by the scratches on the rock that we know that ice was once there; it is by qualities detected in chemical and microscopic examination that we know that a thing is human blood and not paint."[1]

Having now determined the logical status which data occupy and the rôle they play in reflection, we may proceed to a description of the technique by means of which they are ascertained. This involves an account of the processes by means of which complex wholes are analyzed into parts

[1] *Ibid.*, p. 43.

(the second step in Descartes' method), together with the processes connected with the discovery, observation, and orderly arrangement of facts for the purpose of further intellectual treatment.

2. ANALYSIS The characteristic mark of reflection is the severance of the original unity of experience into two elements, data (the facts in the case) and meaning (the body of conceptual material to be used as possible interpretations of the facts). The intellectual operation by means of which this is accomplished is analysis. It should be remembered that analysis involves the ascertainment of meanings (interpretative material, fruitful analogies, suggestions of possible solutions) as well as data, although it is with analysis in connection with the amassing of data that we are at present primarily concerned.

Analysis is a logical process. It is an initial step in the technique of problem solving. It means the resolution of the gross total situation into elements in order to give the parts prominence. To quote Professor James: "Analysis of a thing means separate attention to each of its parts."[1] The operation is undertaken in order to provide for thought a definite point of departure and to secure for in-

[1] *Psychology,* Vol. I, p. 503.

ference and judgment a factual basis. We cannot solve a problem as a whole. It is necessary to take the problem apart, to collect and arrange all the factors suspended in it or in any way connected with it. We may again quote Professor James:

> "To reason, then, we must be able to extract characters—not *any* characters, but the right characters for our conclusion. If we extract the wrong character, it will not lead to that conclusion. Here, then, is the difficulty: *How are characters extracted, and why does it require the advent of a genius in many cases before the fitting character is brought to light?* Why cannnot anybody reason as well as anybody else? Why does it need a Newton to notice the law of the squares, a Darwin to notice the survival of the fittest? To answer these questions, we must begin a new research, and see how our insight into facts naturally grows.
>
> "All our knowledge at first is vague. When we say that a thing is vague, we mean that it has no subdivisions *ab intra,* nor precise limitations *ab extra;* but still all the forms of thought may apply to it. It may have unity, reality, externality, extent, and what not—

thinghood, in a word, but thinghood only as a whole. In this vague way, probably, does the room appear to the babe who first begins to be conscious of it as something other than his moving nurse. It has no subdivisions in his mind, unless perhaps the window is able to attract his separate notice. In this vague way, certainly, does every entirely new experience appear to the adult. A library, a museum, a machine shop, are mere confused wholes to the uninstructed, but the machinist, the antiquary, and the bookworm perhaps hardly notice the whole at all, so eager are they to pounce upon the details. Familiarity has in them bred discrimination. Such vague terms as 'grass,' 'mould,' and 'meat' do not exist for the botanist or the anatomist. They know too much about grasses, moulds, and muscles. A certain person said to Charles Kingsley, who was showing him the dissection of a caterpillar, with its exquisite viscera, 'Why, I thought it was nothing but skin and squash!' A layman present at a shipwreck, a battle, or a fire is helpless. Discrimination has been so little awakened in him by experience that his consciousness leaves no single point of the complex situation accented and standing out for

him to begin to act upon. But the sailor, the fireman, and the general know at what corner to take up the business. They 'see into the situation'—that is, they analyze it—with their first glance. It is full of delicately differenced ingredients which their education has little by little brought to their consciousness, but of which the novice gains no clear idea."[1]

Analysis, therefore, means the direction of attention to separate details in order to grasp their relative weight and significance. Upon what, then, does ability to distinguish and discriminate depend? Again let us turn to James for an answer.

"Our first way of looking at a reality is often to suppose it simple, but later we may learn to perceive it as compound. This new way of knowing the same reality may conveniently be called by the name of *analysis*. It is manifestly one of the most incessantly performed of all our mental processes, so let us examine the conditions under which it occurs.

"I think we may safely lay down at the outset this fundamental principle, that *any total impression made on the mind must be unanalyzable, whose elements are never experi-*

[1] *Psychology*, Vol. II, pp. 343-44.

enced apart. The components of an absolutely changeless group of not-elsewhere-occurring attributes could never be discriminated. If all cold things were wet and all wet things cold, if all hard things pricked our skin, and no other things did so; is it likely that we should discriminate between coldness and wetness, and hardness and pungency respectively? If all liquids were transparent and no non-liquids were transparent, it would be long before we had separate names for liquidity and transparency."[1]

3. OBSERVATION. Intelligence, says Mr. Santayana, depends on quickness in seeing things. A survey and analysis of the facts that constitute a problem requires careful and accurate observation. While seeing is not thinking, *clear* thinking depends on *clear* seeing. Observation, therefore, is inherently related to reflection. The two processes are continuous. It is not that we first observe and then think; it is rather that observation is one of the processes in terms of which reflection goes on. This follows from the fact that the analysis of a non-reflective situation into data is a work of reflection. We may quote Professor Creighton:

[1] *Psychology,* Vol. 1, p. 502.

"To observe well, it is necessary to be more or less definitely conscious of what one is looking for, to direct one's attention toward some particular field or object; and to do this implies selection among the multitude of impressions and objects of which we are conscious. Moreover, scientific observation requires analysis and discrimination. It is not unusual, in textbooks on logic, to symbolize the various facts learned through observation by means of letters *a, b, c, etc.,* and to take it for granted that they are given in our experience as distinct and separate phenomena; but, as we have just seen, judgments of analysis and discrimination are necessary to separate out the so-called 'phenomena' from the mass or tangle of experience in which they were originally given. Again, to determine the nature of a fact through observation, it is essential to note carefully how it differs from other facts with which it is likely to be confused, and also, to some extent, what relations and resemblances it has. But such knowledge presupposes that thought has already been at work in forming judgments of comparison."[1]

[1] *Logic,* p. 211.

The continuity of observation and thinking may be illustrated by noting the character of action when one is engaged in a new venture. Prompted by the impulse of curiosity, one begins, let us say, to explore a cave. He looks to see how far he may safely go. He stops to think if it would be safe to go farther. His action expresses a balanced rhythm of advance and retreat. How much does what is *seen* warrant and encourage one to go farther? How much is the impulse to advance checked and restrained by what one *knows* about the dangers of caves? The exploration progresses in terms of aggression encouraged by observation and caution regulated by thought. What one ought to do depends on the facts observed, and the facts noted are judged and interpreted in terms of a wider knowledge and experience.

There is a vast difference between looking and seeing. Any one may stand and stare. But listless and half-dreamful perception is not observation. Observation requires an active and energetic, a watchful and searching, attitude of mind. To observe is to look carefully with a definite purpose in view. When you make an observation you survey the facts with a question in mind. Some one asks whether it is raining, and I look out in order to see. I observe when there is something to look *for*. In

terms of reflection, I resolve the gross total situation into its elements in order that thought may have something to go on, some basal material for further inference. The facts are observed as means and resources of inquiry. Observation, therefore, requires the continual exercise of thought. To make an examination, as for example a medical diagnosis, requires a background of wide knowledge and experience. Observation is, as Professor Creighton says, "an intellectual activity." We may quote him further:

> "Sometimes the relation between Observation and Explanation is stated in quite a misleading way. It is said that in undertaking an investigation we must observe and describe the facts as accurately as possible, and only after this is done proceed to theories and explanations. Now, as has been shown, this is to make an artificial separation between collecting and describing facts, and relating or explaining them. As we have seen, both processes go on simultaneously. The observation of instances presupposes some guiding idea, some provisional hypothesis, perhaps held in the mind as a question to be answered. We discover the relevant facts as we go along with

our investigation, just as we discover the appropriate conception or explanation. And just as the facts observed and described involve theories and conceptions, so the explanation to which we proceed is simply a fuller and more accurate description."[1]

To observe accurately is a matter of extreme difficulty. We ordinarily suppose that there is nothing simpler than opening our eyes and looking at what is there to be seen. But as a matter of fact one of the most difficult things in connection with reflection is to discover all of the elements connected with a problem and to give a faithful and literal report of them. The following incident described by Professor Münsterberg will serve as an illustration:

"A few years ago a painful scene occurred in the class-room of a famous criminologist. The Professor had spoken about a book. One of the older students suddenly shouts, 'I wanted to throw light on the matter from the standpoint of Christian morality!' Another student throws in, 'I can not stand that!' The first starts up, exclaiming, 'You have insulted me!'

---

[1] *Logic*, p. 208.

The second clenches his fist and cries, 'If you say another word . . .' The first draws a revolver. The second rushes madly upon him. The Professor steps between them and, as he grasps the man's arm, the revolver goes off. General uproar. In that moment the Professor secures order and asks a part of the students to write an exact account of all that has happened. The whole had been a comedy, carefully planned and rehearsed by the three actors for the purpose of studying the exactitude of observation and recollection. As mistakes there were counted the omissions, the wrong additions, and the alterations. The smallest number of mistakes gave twenty-six per cent of erroneous statements; the largest was eighty per cent. . . . Words were put into the mouths of men who had been silent spectators during the whole episode; actions were attributed to the chief participants of which not the slightest trace existed; *etc.*"

Of course one reason for the large number of mistakes was that the observation was not guided by any purpose, there having been no instructions given as to what one was to look for.

(a) *Errors in Observation.* Mistakes in ob-

servation are usually classified by logicians into two classes: namely, non-observation and mal-observation. Non-observation means over-looking; it is the same thing as incomplete analysis. It is important in the initial survey of a problem to assemble all the facts which have any bearing on the difficulty. The task of analyzing a situation into its ultimate elements is a difficult one. No words are more frequently on our lips than these: I failed to see that; this escaped my notice; I overlooked that; I didn't take that into account. Stupidity is for the most part negative in character and is to be traced to the sins of omission. Of himself Professor James writes: "As I sit here, I think objects, and I make inferences, which the future is sure to analyze and articulate and riddle with discriminations, showing me many things wherever I now notice one."[1]

As an illustration of incomplete analysis we may point to the fact that it was originally thought that malaria was due to exposure to the night air. The real cause, the infection carried by the mosquito which was active only at night, was entirely overlooked. The following is a somewhat ludicrous illustration of the failure to observe the most im-

[1] *Psychology*, Vol. I, p. 489.

portant factor in the situation. Experiments were being performed in a psychological laboratory to test the color reactions of a raccoon. An elaborate monograph was being prepared setting forth the results of the experiments. Just before the monograph was published it was noticed that a lever which was used in throwing the colors on a screen brushed close to the raccoon's nose when green was displayed and farther away when red was displayed. Further experimentation revealed the fact that the raccoon had not reacted to the colors at all, but had taken his cue entirely from the varying positions of the lever.

Mal-observation, or seeing wrongly, is the second type of error in observation. The type of error is so obvious that nothing is needed further than the citation of illustrations. These are taken from a text-book in logic by A. L. Jones:

> "A straight stick partly immersed in water seems to be bent.
>
> Mirror increases the apparent size of a room.
>
> We sometimes seem to feel the motion of a boat after landing.
>
> There are marked differences in what the ordinary good observer, the artist, and the botanist see in a flower.

Silas Marner mistook Effie's hair for the lost gold.

In Poe's *Sphinx,* a small animal on the window pane is thought to be a large moth of a strange species.

Finding a likeness between an infant and its parents.

Macbeth seeing Birnam Wood coming to Dunsinane."

(b) *Causes of Errors.*—For logical purposes the setting forth of the causes of faulty observation is more important than a classification of the types of error. In doing this, let us first seek to show how the nature of perception and observation admits the possibility of error. Psychology teaches that a pure sensation is an abstraction. This is the same thing as saying that every datum is the vehicle of some meaning. In every perception there are two parts, a sensory core and a marginal meaning. The sensory core is given and is substantially the same for all; the marginal meaning is added and varies with the interest, training, and personal temperature of the perceiver. When, for example, I say I see my brother, what I actually see are certain patches of color and form, and the mind adds the ideational relations which go to make the

meaning of brother. Any concrete perception is part datum and part meaning, so that there is an intellectual or inferential element in all perception. It is the addition of this inferential element that makes error possible. The mind may add the wrong interpretation. In our ordinary perceptions the meanings are so closely blended with the data that we fail to distinguish between them. It is just because this addition of meaning is made so unconsciously that wrong additions can be made so imperceptibly. The source of error is to be sought for the most part in the way in which the mind interprets and elaborates what is immediately given to the senses. In addition to the psychological sources of error there are physical and physiological ones, but they are largely independent of logical treatment and may, therefore, be omitted.

Francis Bacon, who is often called the father of modern induction, and who has written so much that is valuable for the guidance of inductive procedure, has left us a classical classification of typical errors which should be a part of the student's education. Using the somewhat fantastic name of Idols, he has enumerated four sources of error.

"Four species of idols beset the human mind, to which (for distinction's sake) we

have assigned names, calling the first Idols of the Tribe, the second Idols of the Den, the third Idols of the Market, the fourth Idols of the Theatre. . . .

"The idols of the tribe are inherent in human nature and the very tribe or race of men; for the man's sense is falsely asserted to be the standard of things; on the contrary, all the perceptions both of the senses and the mind bear reference to man and not to the universe, and the human mind resembles those uneven mirrors which impart their own properties to different objects, from which rays are emitted and distort and disfigure them.

"The idols of the den are those of each individual; for everybody (in addition to the errors common to the race of man) has his own individual den or cavern, which intercepts and corrupts the light of nature, either from his own peculiar and singular disposition, or from his education and intercourse with others, or from his reading, and the authority acquired by those whom he reverences and admires, or from the different impressions produced on the mind, as it happens to be preoccupied and predisposed, or equable and tranquil, and the like; so that the spirit of man (according to

its several dispositions), is variable, confused, and, as it were, actuated by chance; and Heraclitus said well that men search for knowledge in lesser worlds, and not in the greater or common world.

"There are also idols formed by the reciprocal intercourse and society of man with man, which we call idols of the market, from the commerce and association of men with each other, for men converse by means of language, but words are formed at the will of the generality, and there arises from a bad and unapt formation of words a wonderful obstruction to the mind. Nor can the definitions and explanations with which learned men are wont to guard and protect themselves in some instances afford a complete remedy—words still manifestly force the understanding, throw everything into confusion, and lead mankind into vain and innumerable controversies and fallacies.

"Lastly, there are the idols which have crept into men's minds from the various dogmas of peculiar systems of philosophy, and also from the perverted rules of demonstration, and these we denominate idols of the theatre; for we regard all the systems of phi-

losophy hitherto received or imagined, as so many plays brought out and performed, creating fictitious and theatrical worlds. Nor do we speak only of the present systems, or of the philosophy and sects of the ancients, since numerous other plays of a similar nature can be still composed and made to agree with each other, the causes of the most opposite errors being generally the same. Nor, again, do we allude merely to general systems, but also to many elements and axioms of sciences which have become inveterate by tradition, implicit credence, and neglect."[1]

Another British philosopher, John Locke, has given a classification of the sources of error. His analysis might well be quoted:

"Besides the want of determined ideas, and of sagacity and exercise in finding out and lay ing in order intermediate ideas, there are three miscarriages that men are guilty of, in reference to their reason, whereby this faculty is hindered in them from that service it might do and was designed for. And he that reflects

[1] *Novum Organum*, Aphorisms XLI-XLIV.

upon the actions and discourses of mankind will find their defects in this kind very frequent and very observable.

"1. The first is of those who seldom reason at all, but do and think according to the axample of others, whether parents, neighbors, ministers, or who else they are pleased to make choice of to have an implicit faith in, for the saving of themselves the pains and trouble of thinking and examining for themselves.

"2. The second is of those who put passion in the place of reason, and being resolved that shall govern their actions and arguments, neither use their own, nor hearken to other people's reason, any further than it suits their humour, interest, or party; and these one may observe commonly content themselves with words which have no distinct ideas to them, though in other matters, that they come with an unbiased indifferency to, they want not abilities to talk and hear reason, where they have no secret inclination that hinders them from being tractable to it.

"3. The third sort is of those who readily and sincerely follow reason, but for want of having that which one may call large, sound, roundabout sense, have not a full view of all

that relates to the question, and may be of moment to decide it. We are all shortsighted, and very often see but one side of a matter; our views are not extended to all that has a connexion with it. From this defect I think no man is free. We see but in part, and we know but in part, and therefore it is no wonder we conclude not right from our partial views. This might instruct the proudest esteemer of his own parts, how useful it is to talk and consult with others, even such as come short of him in capacity, quickness, and penetration; for since no one sees all, and we generally have different prospects of the same thing according to our different, as I may say, positions to it, it is not incongruous to think, nor beneath any man to try, whether another may not have notions of things which have escaped him, and which his reason would make use of if they came into his mind. . . .

"In this we may see the reason why some men of study and thought that reason right and are lovers of truth, do make no great advances in their discoveries of it. Error and truth are uncertainly blended in their minds; their decisions are lame and defective, and they are very often mistaken in their judg-

ments; the reason whereof is, they converse but with one sort of men, they read but one sort of books, they will not come in the hearing but of one sort of notions; the truth is, they canton out to themselves a little Goshen in the intellectual world, where light shines, and as they conclude, day blesses them; but the rest of that vast expansum they give up to a pretty traffic with known correspondents, in some little creek; within that they confine themselves, and are dexterous managers enough of the wares and products of that corner with which they content themselves, but will not venture out into the great ocean of knowledge, to survey the riches that nature hath stored other parts with, no less genuine, no less solid, no less useful than what has fallen to their lot, in the admired plenty and sufficiency of their own little spot, which to them contains whatsoever is good in the universe." [1]

An additional source of error both in observation and in thinking is found in the tendency to hurry. As we have seen, reflection is characterized by the intervention of a period of suspense. But men, being primarily creatures of action, have a

[1] *Conduct of the Understanding,* St. John Ed., Vol. I, pp. 27-29.

native propensity to shorten the period of reflection and to hurry into action. As Bacon writes: "We must not then add wings, but rather lead and ballast to the understanding, to prevent its jumping or flying, which has not as yet been done; but whenever this takes place, we may entertain greater hopes of the sciences."[1]

(c) *The Problem of Training.* Observation becomes a logical process when it is taken in a context of inquiry and when special care is taken to regulate the process and to safeguard it against error. Having now classified the types of error and pointed out the sources from which error springs, we may comment on the problem of the training of observation. Just what parts of our mental equipment can be trained and what cannot be trained? To answer this question we must refer to the familiar distinction between one's native ability and his acquired habits and methods and mannerisms. No one can change the physical process of perception. In the case of vision, for instance, no one can see more or less than the nature of the eye permits. That is to say, there is no training in one's native powers of perception.

The question of training is an affair of method.

---

[1] *Novum Organum,* Aphorism CIII.

No one can alter his native genius. What he can do is to improve the way he employs his capabilities. To train one's powers of observation is to improve one's methods of observing. Since training is a matter of method and inasmuch as the method we are seeking to describe is that of scientific procedure, let us examine the way a scientist observes. When an engineer or an astronomer makes an observation, he does so with some definite purpose in mind. Let us suppose that there is a dispute as to the location of a tree close to the dividing line between two tracts of land. When the surveyor looks through the lens of his level, he is not looking to see anything and everything that lies in the field of vision; he wants to know whether a certain tree is to the right or to the left of a given line. The observation is made with that question definitely in mind and the process is regulated and controlled with that end in view.

From this it follows that the essential condition of accurate observation is *definiteness of purpose.* To see one must be on the lookout. The more definitely you know what you want the greater the chances are that you will see it when you run across it. It is necessary, therefore, to keep your problem constantly in mind. There is a vast difference in the significance of what is seen in the case of a man

who visits an industrial organization as a casual sight-seer and the man who goes on an inspection tour. The former just drops in to see what he can see. The latter goes in an attitude of expectancy and alertness. The difference in the character and significance of what is seen in the two cases depends on the interests of the observers, the purpose for which the visit is made, and the degree in which those interests and purposes are interconnected with some definite problem.

In general it may be said that the man who has acute powers of observation is a man who has a great many interests. The facts and details which are always attracting his notice are illustrations of ideas and problems which are constantly before his mind. We say of the perceptually dull, "having eyes to see they see not," not meaning that they fail to see anything, but rather that what they do see is trivial and unimportant. What they lack is not the physical power of perception, but intellectual interest. They have no curiosity; they have no problems; and lacking both, they have no intelligence.

When we ask, "What's the matter?", we nearly always say, "Well, let me see," and then we begin to look for the material (matter) of the difficulty. Before we can answer, "As a matter of fact, so

and so," we must know what the facts of the matter are. It is necessary at the outset to make a survey of the facts which are the material basis of the problem and the initial basis of thought. To avoid the mistake of leaving out important factors (incomplete analysis), it is essential to form the habit of making frequent reviews in order to be sure that we have completely enumerated all of the facts to be considered in connection with the problem. One should make the effort, consciously and deliberately, to take the time to get all the facts which are relevant to a given difficulty. The fourth rule in Descartes' method is applicable here.[1]

4. CLASSIFICATION AND DIVISION. Data, as we have seen, are means to knowing. And when they are so complex and varied that they cannot be marshalled and utilized in their detached and isolated form, it becomes necessary to group them into classes. Classification, therefore, is a logical process involving the orderly assortment and arrangement of data in order that they may be effectively employed in reflection.

[1] While considering the methodology and technique of observation, attention might properly be called to the significance of mechanical aids to observation, as for example, the microscope, the telescope, the spectroscope. Much of the advance of science consists in the invention of instruments for increasing the range and precision of observation. But skill in the use of mechanical instruments seems hardly properly classed as an achievement in logic.

Let us take an illustration in order to show the function of classification as a necessary means to effective reflection. Our problem, let us say, is to formulate a plan for Honors Courses in the University.[1] Data for consideration are obtained by getting reports of all existing Honor Courses as at present given in American colleges and universities. Since nearly all American institutions of learning have some plan of awarding honors a very large mass of material is at hand. Now the material contained in these reports taken in bulk is too unorganized to be of practical use. The widely different plans and practices must be sorted and classified before they can be effectively utilized in the construction of a plan applicable to a given situation. In the first place, some principle must be selected in accordance with which the different types of courses are to be arranged and assorted. Suppose we agree to assort them on the basis of the method by means of which the award of honors is made. An examination of all of the reports from all of the colleges and universities shows that awards are made according to three different

[1] The illustration is adapted from a Bulletin issued by the Nationa Research Council on Honors Courses in American Colleges and Universities.

standards. First, Honors based on average grades in regular courses. Second, Honors based on special work undertaken in addition to the regular program. Third, Honors based on work superseding the regular requirements. Having now determined these three forms of awarding honors, it is now possible to classify the various schools. It is found that a majority of the colleges and universities award honors on the basis of the average grades made in regular courses. About thirty-five institutions make the awards in accordance with the second standard, while only nine at present give honors in accordance with the third plan.

Of course, classification is not a solution of a problem. It is a preliminary step undertaken in order to organize and arrange material in such a form that reflection about it may be facilitated. In the above illustration, for example, one is prepared to think more adequately on the subject after having made the classification. That is to say, classification is not an end in itself. It is made with reference to some purpose, the purpose being determined by the character of the problem under consideration. We classify the students in the university or the books in the library according to the interest we have in mind.

The allied process of classification is division. The logical character of both processes is the same. Classification means the orderly arrangement of separate items into groups. Division means the breaking up of larger groups into smaller ones. The difference is that of an ascending or descending scale.

The importance of classification may be seen from the fact that science is frequently defined as classified knowledge. Its aim is to reduce the qualitative multiplicity of immediate experience to system and order. "Classification is, in short, a device whereby we are enabled to simplify tremendously an environment which would otherwise be too complex for any finite intelligence. If we were obliged to become acquainted with every object and every event, i.e., if things were entirely, and not merely partly, different from each other, adjustment would be impossible, since we should be unable to forecast the behavior of anything. We can anticipate the future and construe the past because certain things behave alike in certain respects. We can prove that certain things have happened in the past because we know what kind of causes are necessary to produce the given effects; we can foretell the future because we know what effects will be produced by the given causes; we

are able to resort to *proof* because certain things can be depended upon to go together."[1]

"Now in the world with which the physicist deals, the profusion of different kinds of occurrence is far greater. There is an almost infinite number of different sorts of physical objects to start with, water, air, earth, trees, houses, trains, animals, cats, granite hills, snow, mosquitoes. Each of these things differs from all the rest in fundamental qualities. Some are cold, some are hot, some are brown, some are slimy, some are loud, some are heavy, some are brittle, some are magnetic. All these things are constantly changing their colors, their sounds, their temperatures, their shapes, their weights, their positions. Amidst all this multiplicity of differences, how are we to find anything that we can count upon? How are we to explain anything, to understand anything in all this welter?

"To the physicist, this hurly-burly does not seem to be a confusion. Rather it seems the soul of orderliness and regularity. He has discovered so much of order in this seeming disorder that he can calmly assure us that there is

[1] Bode, *Logic*, pp. 8-9.

none of these things that he does not in some measure understand. For every change that we observe, he is ready with an explanation showing just why that change took place, and just what change will occur next. Does a hunter elevate his gun and bring down a duck? Then our physicist can tell us exactly the path of the shot, the fall of the bird. Does the six-teeen-inch gun discharge a shell at an invisible target? He can tell us just where it will land, how long it will take, how hot it will be, how great a force drove it, and almost any other question that we may choose to ask. Does something go wrong with the storage battery in our car? He can tell us exactly what has been happening in that little box, and just what the trouble is. The events of nature find him unsurprised, because he has already calculated what they will be. For everyone he can give some kind of reason and explanation. He has found that things happen in certain fixed and invariable ways and that when he has discovered what those ways are, he has the key to every phenomenon that belongs to that class."[1]

---

[1] Columbia Associates, *Introduction to Reflective Thinking,* pp. 121-122.

The technique of classification is exceedingly simple. We begin by selecting a basal principle, technically called *fundamentum divisionis,* and proceed to group the data in accordance with this principle. The principle is determined by the purpose for which the classification or division is made. For example, I may classify the students in the university according to their year in college, or according to their academic record, or according to the college in which they are registered, the principle in each case being selected with reference to the character of the information one is seeking.

The following technical words are frequently used in connection with classification: *genus, species, summum genus, infima species,* and *sui generis.* A *genus* is any class which admits of division into *sub-classes;* a *species* is a sub-division of a higher class. Thus "books" would be a *genus* while "books on history" would be a species. If, however, we further divided "books on history" into "books on English history" and "books on American history," *etc.,* each of these sub-classes would be a *species* whereas "books on history" would be their *genus.* A *summum genus* is the highest genus, that is, the class that contains all the subordinate classes and cannot itself be subordinated to any other class.

An *infima species* is the lowest class, that is, the class that cannot be further subdivided without coming to the individual. Thus, as a form of political organization, the United States government is a *summum genus,* the state would be a *genus,* the county a *species,* the precinct an *infima species.* In this scheme it should be noted that the District of Columbia would have no place. It is, therefore, said to be *sui generis;* it is unique and consequently does not admit of classification; it is in a class of its own and there is no other thing in that class.

A form of division which is frequently used is dichotomy. A dichotomous division is one that divides into two parts on the basis of the presence or absence of some particular attribute. This form of division is used when the object of investigation centers around some special quality the presence or absence of which it is necessary to determine. Before an election, for example, it is important to divide citizens into those who have registered and those who have not. Or again, if the object of my investigation is the study of Honors Courses in universities, I may begin by dividing all universities into those which give Honor Courses and those which do not, the presence or absence of this particular thing being the sole object of my inquiry. Division is subject to two fallacies which are usu-

ally called *incomplete division* and *cross division.* Every division should be made on the basis of a single principle: failure to observe this rule gives rise to cross division, or what is also called overlapping division. The fallacy of incomplete division means that the addition of the species is not equal to the genus *i.e.,* the division has not been exhaustive.

Logicians are accustomed to classifying classifications into two types: artificial and natural. The basis of this classification is found in the character of the principle which is taken as the *fundamentum divisionis.* If the principle is merely arbitrary and is selected with reference to the purpose or interest of some special inquiry, the classification is said to be artificial. If, on the other hand, the selection of a principle is made on the basis of the way things are in nature unordered to suit human purpose, the classification is said to be natural. The following passage descriptive of the logic of Aristotle will serve to clarify the distinction:

> "Why should it be assumed that there is only *one* predicate, *viz., man,* which precisely answers the question, 'What is Socrates?' Why should it not be equally correct to answer, 'A Greek,' or 'a philosopher'? The explanation

is that Aristotle takes it for granted that not all the distinctions we can make between 'kinds' of things are arbitrary and subjective. Nature herself has made certain hard and fast divisions between kinds which it is the business of our thought to recognize and follow. Thus according to Aristotle there is a real gulf, a genuine difference in kind, between the horse and the ass, and this is illustrated by the fact that the mule, the offspring of a horse and an ass, is not capable of reproduction. It is thus a sort of imperfect being, a kind of 'monster' existing *contra naturam.* Such differences as we find when we compare, *e.g.,* Egyptians with Greeks do not amount to a difference in 'kind.' To say that Socrates is a man tells me what Socrates *is,* because the statement places Socrates in the real kind to which he actually belongs; to say that he is wise, or old, or a philosopher merely tells me some of his attributes. It follows from this belief in 'real' or 'natural' kinds the problem of definition acquires an enormous importance for science. We who are accustomed to regard the whole business of classification as a matter of making a grouping of our materials such as is most pertinent to the special question we have in

hand, tend to look upon any predicate which belongs universally and exclusively to the members of a group, as a sufficient basis for a possible definition of the group. Hence we are prone to take the 'nominalist' view of the definition, *i.e.,* to look upon a definition as no more than a declaration of the sense which we intend henceforward to put on a word or other symbol. And consequently we readily admit that there may be as many definitions of a class as it has different propria. But in a philosophy like that of Aristotle, in which it is held that a true classification must not only be formally satisfactory, but must also conform to the actual lines of cleavage which Nature has established between kind and kind, the task of classificatory science becomes much more difficult. Science is called on to supply not merely *a* definition but *the* definition of the classes it considers, the definition which faithfully reflects the 'lines of cleavage' in Nature." [1]

Aristotle's view of natural classification has been of tremendous historical significance. It fixed the goal of science for many centuries, and served to establish the view that contemplative is superior

[1] A. E. Taylor, *Aristotle,* pp. 22-23.

to practical knowledge. Since "species," "kinds," "classes," are unalterable fixities of nature, the purpose of science is to discover and describe them, never to alter or induce them. Classification, being an end in itself, and another name for explanation, was taken to be the final and ultimate goal of science.[1] The view that knowledge is contemplative and that science is classificatory was held until late modern times. It received its first impressive attack from Bacon. It was not, however, until the publication of Darwin's *Origin of Species* that the full significance of the anti-Aristotelian view was fully grasped.[2]

5. STATISTICS. When the collection and amassing of data, their arrangement into orderly and instructive form, and the interpretation of their significance is undertaken on an elaborate and complicated scale, recourse is made to statistics. Statistical method has so developed in technical procedure that it has now become a separate and independent science. Any analysis of its technique, therefore, obviously lies outside the scope of an elementary description of the logic or reflection. Attention is

[1] For an extension of the Aristotelian view of natural classification, to the social sciences and theology, see J. Dewey, *Reconstruction in Philosophy,* Chapter III.

[2] Cf. J. Dewey, *Influence of Darwin on Philosophy.*

here called merely to the logical significance of statistics, that is, to the part which statistics play in reflection. Statistics may be characterized as *socialized* thinking. All the agencies utilized for the collection and preservation of data in all the departments of social interest together with all the various types of bureaus for the keeping of records are means of rendering the common experiences of mankind available for guidance and instruction. By means of statistics, thinking becomes more than a merely individual affair; it becomes a cooperative enterprise, into which the funded results of many experiences enter.

QUESTIONS

1. What is meant by saying that data are possessed of logical significance? Explain the meaning of "logical" in this connection.
2. Define analysis.
3. What, according to James, is the meaning of vagueness?
4. Explain the statement: "To reason we must be able to extract characters."
5. What fundamental principle governs the ability to analyze?
6. Define perception and observation.
7. Explain the statement: "Observation is an intellectual activity." What intellectual operations are correlated with observation?

8. What is meant by the continuity of observation and thinking?

9. What are the two types of faulty observations?

10. Show how the nature of perception admits the possibility of error.

11. Explain the sources of error in the examples cited from Jones on pp. 129-30.

12. How are our powers of observation to be trained?

13. Explain Bacon's idols.

14. What is meant by saying that science is classified knowledge?

15. Explain the statement: "Classification is the basis of intelligibility."

16. State the rules governing classification.

17. What are the fallacies of classification?

18. Explain the following terms: *genus, species, summum genus, infima species, sui generis.*

19. What is meant by a dichotomous division? What are the uses of dichotomy?

20. How do you distinguish natural from artificial classification?

21. What is meant by regarding statistics as socialized thinking?

22. In what fields of inquiry are statistics chiefly employed and what purpose do they serve?

ILLUSTRATIONS

1. Cite an illustration in which the chief task of reflection is the procuring of adequate data. Describe the processes by means of which the data are secured. Against what fallacies was it necessary to guard?

2. Illustrate the relation of analysis to reflection by show-

ing the procedure in describing non-reflective and reflective experience.

3. Illustrate the principle that "any total impression made on the mind must be unanalyzable, whose elements are never experienced apart."

4. Illustrate the continuity of observation and thinking.

5. Give an illustration of incompetent thinking due to incomplete analysis.

6. Illustrate each of Bacon's idols.

7. Give an illustration of mal-observation due to (a) psychological causes; (b) physical causes; (c) physiological causes.

8. Give an illustration in which perception was moulded by (a) point of view; (b) emotion; (c) lack of attention.

9. Illustrate the fallacies of classification.

EXERCISES

1. In the statement, "To reason one must be able to extract characters," does James mean by "characters" data or meanings, or both?

2. Compare point by point James' description of vagueness with the description given of non-reflective experience.

3. Make an analysis of Locke's classification of errors in thinking, pointing out everything that illustrates anything you have learned in connection with the course thus far.

4. What sciences may be termed "classificatory" sciences, and why?

5. How is it that the same object can belong to different classes at the same time? For example, Socrates is a man, Socrates is a Greek, Socrates is a philosopher.

6. The conception that science is mere classification goes back to Aristole. Can you, from the quotation from A. E. Taylor, determine how this conception arose?

7. Compare and contrast analysis and synthesis. Where in

connection with an analysis of reflection do you think synthesis will be properly discussed?

8. How do we tell which data are significant in any situation? Is vividness or conspicuousness a sufficient test? Illustrate with regard to a detective story.

9. Enumerate both the advantages and disadvantages in having a definite purpose in mind in observation.

10. Criticise the point of view expressed in Bacon's idols.

11. Discuss Darwin's statement: "No one can be a good observer unless he is an active theorizer." Compare with Bacon.

12. What part does past experience play in observation? Discuss the mechanic who is able to hear a "knock" in your motor which you cannot hear.

13. Discuss the case of the Indians brought to New York City who marvelled not at the tall buildings, elevated railroads, and automobiles, but at a lineman climbing a pole with patent climbers on his feet.

14. Discuss: "All immediate recognition is unconscious classification."

15. In a dichotomy, is it possible to subdivide the negative group?

16. Distinguish the following relations: species to genus, individual to group, and part to whole. Illustrate each.

CHAPTER SIX

MEANING

We have taken the severance of the original unity of experience into data and meaning as the characteristic distinction between reflective and non-reflective experience. Having in the preceding chapter made a logical analysis of data, we turn in the present chapter to an analysis of the concept of meaning. We must seek to fix the precise meaning of the concept as it is employed in logical analysis, that is, as an instrumentality in knowing coordinate and cooperative with data.

1. OBSERVATION AND INFERENCE. We may begin with the distinction between observation and inference. Observation deals with data, inference deals with meaning. Observation is concerned with the facts which are directly and immediately given in perception; inference is concerned with what those facts suggest and with what constructions are placed upon them. Suggestions and interpretations can not be observed, they can only be thought. It should be remembered, however, that

the distinction between perception and inference is only relative. We have already seen that there is an inferential element in all perception. That is to say, there is no datum which is not invested with some meaning, for otherwise it would not be an intelligible object at all. But granted that datum as datum carries a certain weight of meaning, it is important to distinguish the datum from the further inferences which might be drawn from it. For example, a cloud suggests rain. The cloud as a sense fact is a meaningful datum, but from that datum rain as something distinguished from it is suggested by it, that is, is inferred.

The literal meaning of the phrase "to infer" is to carry or to bear. Inference, therefore, expresses a certain movement of thought. Perception is direct and is limited to what is immediately given to the senses. Inference is the function by means of which we transcend the limits of sense and pass by a movement of thought from what is present to what is absent. For example, one says to me: "I gather from what you say that you expect to leave town." What I say is a fact which is perceived; my leaving town is an additional construction placed on the fact. Thackeray says of a certain man: "His imbecility of character might have been inferred from his proneness for favorites." "Proneness for favorites" is a datum of perception,

"Imbecility of character" is an inference drawn from it; it is what the datum means. Synonyms for inference are such words as suggestion, indication, signification, implication, *etc.* Each of these words has a carrying power and leads over from a thing which is given to another thing which is not given. Such words as sign, emblem, token, signal, symptom, are highly charged with inferential significance. When, for instance, we say that one thing presages another, we mean that a thing which is present calls up something else which is yet to come. Whenever one has an expectation he takes something which is going on (data) as the sign of something to follow (meaning).

The mind passes by an act of thought from a sign to the thing signified, from a symbol to the thing of which it is symbolic. The sign is observed, the thing signified is inferred. Observation issues in the declaration of a fact; inference passes beyond the fact to what is as yet not observed. For example, I observe that a book is on the table, but knowing that it was not there when I left the room, I infer that some one came in during my absence.

The following passage on the nature of inference is quoted from Professor Dewey:

> "The correlate in thinking of facts, data, knowledge already acquired, is suggestions,

inferences, conjectured meanings, tentative explanations: *ideas* in short. Careful observation and recollection determine what is given, what is already there, and hence assured. They cannot furnish what is lacking. They define, clarify, and locate the question; they cannot supply its answer. Projection, invention, ingenuity, devising come in for that purpose. The data *arouse* suggestions, and only by reference to the specific data can we pass upon the appropriateness of the suggestions. But the suggestions run beyond what is, as yet, actually *given* in experience. They forecast possible results, things *to* do, not facts (things already done). Inference is always an invasion of the unknown, a leap from the known."[1]

2. INFERENCE AND MEANING. Inference denotes both product and process. As product it refers to the thing inferred, as process it refers to the act of inferring. In the passage from a sign to the thing signified, the sign is a datum, the thing signified is the thing inferred, *i.e.,* the inference in the substantive meaning, the process as a whole is inference in its verbal signification. In order to avoid the ambiguity involved in the substantive

[1] *Democracy and Education,* p. 186.

and verbal use of the word inference, let us use the word meaning, which is a noun and not a verb, to stand for the thing inferred, that is, for inference in its substantive connotation. The datum is the thing meaning, the meaning is the thing meant, and inference limited to its verbal signification is the word descriptive of the process as a whole. The word 'thing' is purposely used in a very broad and loose sense. Meanings, as well as data, as we shall see later, may mean meanings, and both meanings and data may be things meant.

The distinction between data and meaning, when generalized, yields the distinction between physical and mental, the objective and subjective, the real and the ideal. Data are physical and constitute the realm of *existence;* meanings are mental and constitute the realm of *essence.* This may be expressed differently by saying that things may be present to consciousness in two ways: they may be present as data, and then they are said to be physical; they may be present as meanings, and then they are said to be mental. And just as the distinction between data and meaning represents a "working or instrumental division of labor" (Dewey) and not a "rigid and ready-made structural difference of reality" (Dewey), so the physical and mental do not define separate realms of

being. The distinction is methodological and not metaphysical. Mind and Body are not given actualities of experience; they represent the severance of the original unity of non-reflective experience into the real and the ideal, into something given and something sought, a severance made in the interest of adjustment and control. If things in being known separate into data and meaning, then objectivity (physical) and subjectivity (mental) occupy the same metaphysical status. The distinction between mind and body is, therefore, a logical distinction.

3. Two Meanings of Meaning. A further analysis of the concept of meaning leads to a distinction between two meanings of meaning. The two meanings are intrinsic and extrinsic.

(a) *Intrinsic.* Illustrations may best serve the purpose of identifying the intrinsic meaning of meaning. When I am thirsty, I pick up a glass of water and drink it; when I am tired, seeing a chair, I sit down in it. The data, water and chair, are both possessed of meaning. I know that water is a thing to be drunk when one is thirsty; I know that a chair is a thing to be sat in when one is tired. In each case the meaning is taken as an integral part of the datum; it is blended with it and is as much a part of it as any of its purely sense qualities. No

distinction is made between datum and meanings; the two coalesce and fuse into one single and indivisible object of experience. The meaning is an intrinsic quality, an immediate value, a resident attribute of thinghood. It does not point to anything beyond the datum. It is an elaboration and interpretation of what the datum really is; it gives significance, value, importance to it.

Of course, the meanings were not always there. There was once a time when I did not know what water or chairs were for. But we must not confuse the origin of meanings with the way they operate after they have been established. Once the meaning is acquired it is subsequently intuited[1] with the same assurance of objective reality as the datum which is its sensory vehicle. Meanings once assigned as intrinsic qualities of objects are then as immediately given in intuition as sense data. In fact, a pure sense datum, that is, a datum possessed of no meaning, is a pure abstraction. All the common objects of ordinary life are interpenetrations of data and meanings. Horses and dogs, knives and forks, needles and thread, are all meaningful things in non-reflective experience.

The power to intuit meanings in this intrinsic

[1] The word *intuition* is used as descriptive of the process involving the direct and immediate apprehension of meaning.

sense is possessed by animals as well as by human beings. Perhaps not even the lowest animal is immersed wholly in sense. They seek and shun objects with an amazing amount of appropriateness. If all one means by intelligence is reaction to intrinsic meaning, then we must conclude that animals have intelligence.

Intrinsic meanings may be illustrated in the following passage from Professor James:

> "There are other shorter flights of thought, single couplings of terms which suggest one another by association, which approach more to what would commonly be classed as acts of reasoning proper. Those are where a present sign suggests an unseen, distant, or future reality. Where the sign and what it suggests are both concretes which have been coupled together on previous occasions, the inference is common to both brutes and men, being really nothing more than association by contiguity. A and B, dinner-bell and dinner, have been experienced in immediate succession. Hence A no sooner falls upon the sense than B is anticipated, and steps are taken to meet it. The whole education of our domestic beasts, all the cunning added by age and experience to wild

ones, and the greater part of our human knowingness consists in the ability to make a mass of inferences of this simple sort. Our 'perceptions,' or recognitions of what objects are before us, are inferences of this kind. We feel a patch of color, and we say 'a distant house,' a whiff of odor crosses us, and we say 'a skunk,' a faint sound is heard, and we call it 'a railroad train.'"[1]

Meanings of this intrinsic kind are of no logical significance. Intuition of intrinsic meaning is in no sense a cognition. Meanings are possessed of logical character when they are distinguished from data and are employed in reflection as means to knowing. In this intrinsic use of meaning, the meaning is not disentangled from the datum, and the experience in which it functions is practical and active rather than cognitive or reflective. The thing and its meaning exist on the same plane of reality, both are equally real and equally objective. When we are dealing with intrinsic meanings we are dealing with thinghood, not with knowledge or cognition. It is in the sense of intrinsic qualities that meanings operate in non-reflective experience. It is just because the meanings are fully

[1] *Psychology,* Vol. II, p. 326.

and adequately grasped, as completely so as the sense qualities, that no investigation or inquiry is needed. When a thirsty person drinks water, he perceives its meaning as readily and as immediately as its sparkle.

Intrinsic meanings, therefore, play a practical rôle. They serve as cues to action. We have already distinguished reflective from non-reflective experience on the basis of the distinction between knowledge and action. Man is primarily a being who acts and only secondarily one who knows. It is only when the unity of action is broken that reflection arises as a means to restoring the unity. Action increases in security and control to the extent that the objects of the environment are overlaid with significant meanings. A man takes his place in a complicated environment, for example, a great city or an elaborate social function, just to the extent that he takes in the meaning of the complex objects that assail his senses. It is only when the meaning of these objects is imperfectly grasped that he becomes bewildered or embarrassed and resorts in a self-conscious way to reflection.

A second use of intrinsic meaning is found in esthetic appreciation. It is of course beyond the field of logic to undertake any analysis of esthetic

appreciation. It is interesting, however, to note the contrast between the method of reflection and the method of direct and immediate enjoyment. As an illustration of the rôle of intrinsic meanings in esthetic experience we may quote Schopenhauer.

> "If raised by the power of the mind, a man relinquishes the common way of looking at things, gives up tracing under the guidance of the forms of the principle of sufficient reason [reflective thinking], their relation to his will: if he thus ceases to consider the where, the when, the why, and the whither of things, and looks simply and solely at the *what;* if further, he does not allow abstract thought, the concepts of the reason, to take possession of his consciousness, but, instead of all this, gives the whole power of his mind to perception, sinks himself entirely in this, and lets his whole consciousness be filled with quiet contemplation of the natural object actually present, whether a landscape, a tree, a mountain, a building, or whatever it may be; inasmuch as he *loses* himself in this object (to use a pregnant German idiom), i.e., forgets even his individuality, his will, and only continues to exist as the pure subject, the clear mirror of the object, so that

> it is as if the object alone were there, without any one to perceive it, and he can no longer separate the perceiver from the perception, but both have become one, because the whole consciousness is filled and occupied with one single sensuous picture, if thus the object has to such an extent passed out of all relation to something outside it, and the subject out of all relation to the will, then that which is so known is no longer the particular thing as such; but it is the *Idea,* the eternal form, the immediate objectivity of the will at this grade; and, therefore, he who is sunk in this perception is no longer individual, for in such perception the individual has lost himself; but he is *pure,* will-less, painless, timeless *subject of knowledge."* [1]

Reflective thinking and esthetic enjoyment are further contrasted by Schopenhauer as follows:

> "The first is the method of Aristotle; the second is, on the whole, that of Plato. The first is like the mighty storm, that rushes along without beginning and without aim, bending, agitating. carrying away everything before it;

[1] *The World as Will and Idea,* Eng. tr., Haldane and Kemp, Vol. I, p. 231.

the second is like the silent sunbeam that pierces through the storm quite unaffected by it. The first is like the innumerable showering drops of the waterfall, which, constantly changing, never rest for an instant; the second is like the rainbow, quietly resting in this raging torrent."[1]

(b) *Extrinsic.* There is a second meaning of meaning, the sense in which it functions in reflection. In this sense the meaning is not so much an enhancement of the thing as a vehicle of reference. The thing meaning has an extrinsic reference, it mediates, it points to something beyond itself. Things meaning are signs of things meant. "In reflection the extrinsic reference is always primary" (Dewey). It is the sign-bearing quality of meanings that renders them suitable instruments of knowing and that endows them with logical properties. It is just because the meaning carries over from something which is given (datum) to something which is inferred that the possibility of error arises and hence the need for regulation and control of the process. The thing which is inferred is believed in on the evidence of what is given and hence becomes a subject of logical treatment.

[1] *Ibid.*, pp. 239-240.

There are two types of extrinsic meaning which in the interest of logical analysis it is important to distinguish. These two types are *perceptual* inference and *conceptual* inference.

(1) Perceptual inference: A perceptual inference is one in which the meaning is suggested by a sense datum. The sight of one person reminds me of another, the advent of summer suggests taking a vacation, a certain food is associated with the place where I first ate it; in these instances the meaning springs from particular sense data. Let us use the word *indication* for perceptual inference. Thus we should say that the clouds indicate rain, that the symptoms indicate typhoid fever.

(2) Conceptual inference: In order to understand conceptual inference, let us first explain the meaning of the term concept. Over against the world of sense data, constituting the realm of existence, is the body of concepts, constituting the realm of essences. A sense datum is a particular existence, a thing which can be pointed to as a this or a that, some individual thing given in perception. As we have seen, sense data indicate other possible data. For instance, the cloud indicates rain. The thing indicated, raining, is a particular meaning, *i.e.,* the thing meant is a particular datum, but of course, a datum inferred and not

observed. If seeing the clouds and thinking of rain, I immediately pick up my umbrella without hesitation or delay, there is strictly speaking no reflection involved, but only a perceptual inference. But if the response is delayed, if the action is held off, and if the thing indicated, namely rain, is held up as a possibility, and if the possibility is utilized as a means of a more careful survey of the clouds, and if the resulting action is modified as a result of the operation, then we have a fully developed meaning. Not the particular existence, raining, but the general idea, rain; rain, here, there, everywhere, is employed. Meanings work loose from things meant, and operate independently. They become weighted with representative reference, that is, they become concepts. A concept, therefore, is a standardized meaning. When meanings are entirely disentangled from things meant they become concepts. Concepts are, consequently, general as opposed to data, which are always particular. Their generality consists in their representative applicability and not in their existential ingredients. All general ideas, all class terms, all common nouns, are concepts. They cannot be perceived; they can only be thought.

Having now explained the meaning of a concept, we may proceed to describe the process of

conceptual inference. A conceptual inference is one in which the meaning springs from a concept. It involves the deduction of theoretical implications. This type of inference takes the form: If P, then Q, or P implies Q, where P is a concept and Q is an implication. Thus the concept of circularity implies the equality of the radii of the circle. Or I may say that if a man is honest he will not steal. Not stealing is a trait which is implied in the concept of honesty. Implication is the prevailing form of inference in deductive mathematics. The various properties of the triangle are implied in the concept of triangularity. The natural sciences are constantly drawing conceptual inferences. The biologist, for instance, takes the concept of evolution as a working hypothesis, and proceeds to deduce from it certain theoretical implications. He reasons that if evolution is true, then certain additional facts ought to follow from it, *i.e.,* are implied in it. He is thus able to guide his investigation, for he then knows what to look for. Similarly, the physicist reasons about the Einstein theory. The truth of the theory implies a shift in the lines of the spectrum, a bending of a light ray due to gravitational pull, *etc.* In these and similar instances, the inferences are drawn from concepts and not from sense data.

Let us, accordingly, use the term indication to stand for perceptual inference, and implication to stand for conceptual inference. "As data are signs which *indicate* other existences, so meanings are signs which imply other meainngs."[1]

Let us now illustrate the function of implication in reflection. It is because standardized meanings have a representative value, that is, because implications can be deduced from them, that they can be utilized in reflective thinking. The concept, honesty, means (implies) *b* and *c*. An observed trait, *a* (sense datum), suggests honesty. But honesty implies *b* and *c*. These implications enable me to make further observations with a view to the discovery of *b* and *c*. Implication, therefore, is the very heart of reflection, and constitutes, as we shall see later, the deductive part of reasoning. Furthermore, implication constitutes the distinguishing feature of man as contrasted with the lower animals. It seems quite certain that animals are

[1] Dewey, *Essays in Exp. Log.*, p. 52.

One may carry the analysis of inference still further and point out two subdivisions under each type. Thus:

I. Perceptual inference. Indication.
   1. From sense data to sense data; *i.e.*, from particular to particular.
   2. From sense data to meaning; *i.e.*, from particular to general.

II. Conceptual inference. Implication.
   1. From meaning to meaning; *i.e.*, from general to general.
   2. From meaning to data; *i.e.*, from the general to the particular.

capable of perceptual inference. But it seems exceedingly doubtful whether they are capable of drawing the implications from a concept and using those deduced implications as regulating principles in further experience.

Briefly to summarize, we shall employ the term meaning to stand for the body of interpretative material, of explanatory conceptions which are used in any cognitive experience. Confronted with a problem, we invariably ask the following questions: What can you *suggest?* What is your *idea?* What do you *think* should be done? What have you in *mind?* Suggest, idea, think, mind: these words are descriptive of mental procedure. Together they constitute the realm of meaning, and together with data, the facts in the case, are employed as instruments in reflection.

The following quotation from Professor Dewey will serve to summarize the function of meaning in reflection:

> "We shall merely summarize, saying that conceptions, or standard meanings, are instruments (1) of identification, (2) of supplementation, (3) of placing in a system. Suppose a little speck of light hitherto unseen is detected in the heavens. Unless there is a store of mean-

ings to fall back upon as tools of inquiry and reasoning, that speck of light will remain just what it is to the senses—a mere speck of light. For all that it leads to, it might as well be a mere irritation of the optic nerve. Given the stock of meanings acquired in prior experience, this speck of light is mentally attacked by means of appropriate concepts. Does it indicate asteroid, or comet, or a new-forming sun, or a nebula resulting from some cosmic collision or disintegration? Each of these conceptions has its own specific and differentiating characters, which are then sought for by minute and persistent inquiry. As a result, then, the speck is identified, we will say, as a comet. Through a standard meaning, it gets identity and stability of character. Supplementation then takes place. All the known qualities of comets are read into this particular thing, even though they have not been as yet observed. All that the astronomers of the past have learned about the paths and structure of comets becomes available capital with which to interpret the speck of light. Finally, this comet-meaning is itself not isolated; it is a related portion of the whole system of astronomic knowledge. Suns, planets, satellites,

nebulae, comets, meteors, star dust—all these conceptions have a certain mutuality of reference and interaction, and when the speck of light is identified as meaning a comet, it is at once adopted as a full member in this vast kingdom of beliefs."[1]

4. Meaning and Idea. Meanings, by virtue of their sign-bearing capacity, are possessed of logical properties. They come to assume a cognitive rôle when they are employed as instruments in knowing and when special care is taken to investigate the evidence which supports them. Examine each of the words in the following list:

	Vague impression	
	Hint	
	Clue	
	Conjecture	
	Guess	
	Suggestion	
Problem	Supposition	Solution
	Assumption	
	Plan	
	Program	
	Policy	
	Hypothesis	
	Theory	

[1] *How We Think*, pp. 126-127.

Each of these words points in two directions; it points backwards to a problem, and it points forward to a solution. Each word has interpretative significance, it serves as a tentative explanation. Let us use the word "idea" to stand for any meaning that is employed in reflection. For a precise definition of idea, we may quote that given by Professor Dewey: "An idea is a meaning that is tentatively entertained, formed, and used with reference to its fitness to decide a perplexing situation —a meaning used as a tool of judgment." [1] Any one of the above words becomes an idea when it is taken in a cognitive context and seriously entertained as a possible solution to a problem. A meaning as meaning is not an idea, it becomes an idea when it is used as an instrument in knowing. An idea is a candidate for belief without all of the necessary grounds for acceptance.

Ideas, therefore, have an instrumental rôle to play. They are proposals addressed to activity at a time when action is in doubt. Consider the following illustration of the meaning and function of ideas taken from practical experience:

> "Traveling in the smoking compartment of a train, I talked for an hour with the buyer-

---

[1] *How We Think*, p. 108.

manager of a western department store about merchandizing.

"From him I got five ideas: first, to get rid of traditions and personal likings or prejudices in making decisions or purchases; second, to buy nothing you can not sell at a profit, either in money or advertising, and to judge every article bought from the customer's point of view; third, to turn over your stock as often as possible; fourth, to give full and exact measure but no more at each sale; fifth, to know your costs and what makes them, and to cut them to the lowest point without sacrificing quality and service."

Each of these ideas is a thing to be tried, it is a guiding principle of action. Ideas are means of giving scope and breadth to one's work. They are out-looks, points of view, means of widening and enlarging the sphere of action and of rendering it more effective. All ideas are meanings, but not all meanings are ideas. Only those meanings which are taken in a context of inquiry and which are tentatively entertained pending investigation are ideas. Concepts in themselves are not ideas, but they become ideas when they are used as means to knowing, as modes of interpretation, as methods

of inquiry. "Ideas are not then genuine ideas unless they are tools in a reflective examination which tends to solve a problem." [1]

5. ORIGIN OF MEANING. Data and meaning are cooperative instrumentalities employed in reflection. They constitute the realm of existence and the realm of essence respectively. The realm of essence includes the entire body of interpretative material and explanatory conceptions which the mind brings to bear in the logical analysis of experience. It includes meanings, concepts, ideas, and, as we shall later see, principles and laws. We may now inquire into the origin of this world of meaning. How does it come about that there is a realm of essence? Many different answers have been given to this question. Chiefly because of its historical interest we may select the one given by Plato. Plato was one of the first of the philosophers to be concerned with the problem of knowledge and of how it is possible. His immediate predecessors, the Sophists, had attempted to explain knowledge entirely in terms of sense data. They had not as yet discovered the realm of essence. Plato's chief merit consists in his dis-

---

[1] J. Dewey, *How We Think*, p. 109.

covery of the fact that meanings as well as data are necessary means to knowledge. Take, for example, Diogenes, with his lantern wandering through the streets of Athens in search of an honest man. Now Diogenes must first know what honesty is before he can recognize a case of it in any given instance. The general idea, therefore, is logically prior to its application in experience. When I judge two lines to be nearly equal, I make use of the concept of equality, using it as a standard of comparison. It seems, then, that any particular case of knowing implies the existence of something antecedently known. Now where does the mind get the meanings in terms of which it begins its cognitive experience?

Now, according to Plato, lines are sense data; they are given in perception. But equality, the concept in terms of which I judge them, is never a sense datum. I never find in sense experience an illustration of the just equal, of the perfectly round. Lines and circles which I draw always fall a little short of absolute exactness: they are only approximations. Perfect equality or perfect circularity is nowhere to be found in the realm of existence. Now obviously I cannot get out of experience what is not in it. It is useless then, according to Plato, to talk of an empirical (perceptual) origin

of equality, or circularity, or of any other general concept. Yet these concepts must somehow be, since no knowledge is possible without them. Where, then, do they come from? How do they originate?

Now Plato thought that the soul pre-existed in another world long before it came down to inhabit human bodies. And that other world where our souls once were, was a world of pure essences. There were no circles there, but just circularity; no honest men, but just honesty, no beautiful pictures, but just beauty. That is, it was a realm in which there were just meanings, and no sense data at all. All the types and patterns, all the kinds and forms, all the perfect models and ideal logical concepts were to be found there. The soul in its previous existence dwelt in this realm of essences and acquired a very good knowledge of them. But when the soul was born into a human body it became a little dulled and forgot most of its previous knowledge. However, in moments of exceptional lucidity it is faintly reminiscent of its life amidst logical essences. And so when it perceives the more or less equal, aided by this sensuous copy, the soul recalls perfect equality, and so is able to live a cognitive life.

Modern psychologists are generally agreed that

Plato's account of the origin of meanings is poetic and fanciful rather than factual. Contrary to Plato, it is held that the mind has no way of acquiring ideas except through experience. John Locke was one of the first modern philosophers to emphasize the empirical origin of meanings and ideas. He thus writes of the origin of ideas:

> "Let us then suppose the mind to be, as we say, white paper, void of all characters, without any ideas; how comes it to be furnished? Whence comes it by that vast store which the busy and boundless fancy of man has painted on it with an almost endless variety? Whence has it all the materials of reason and knowledge? To this I answer in one word, from experience; in that all our knowledge is founded, and from that it ultimately derives itself."[1]
>
> "All those sublime thoughts which tower above the clouds, and reach as high as heaven itself, take their rise and footing here: in all that good extent wherein the mind wanders, in those remote speculations it may seem to be elevated with, it stirs not one jot beyond those

[1] *Essays Concerning Human Understanding,* Bk. II, 1, 2.

ideas which sense and reflection have offered for its contemplation."[1]

Concerning our ideas, Thomas Hobbes writes:

"The original of them all is that which we call SENSE, for there is no conception in a man's mind, which hath not at first, totally or by parts, been begotten upon the organs of sense. The rest are derived from that original."[2]

A similar passage may be cited from Hume:

"Nothing, at first view, may seem more unbounded than the thought of man, which not only escapes all human power and authority, but is not even restrained within the limits of nature and reality. To form monsters, and join incongruous shapes and appearances, costs the imagination no more trouble than to conceive the most natural and familiar objects. And while the body is confined to one planet, along which it creeps with pain and difficulty; the thought can in an instant transport us into the most distant regions of the universe; or even beyond the universe, into the unbounded chaos, where nature is supposed to lie in total confusion. What never was seen, or heard of,

---

[1] *Ibid.*, II, 1, 25.

[2] Hobbes, *Leviathan*, Part I, Chap. I.

may yet be conceived; nor is anything beyond the power of thought, except what implies an absolute contradiction.

"But though our thought seems to possess this unbounded liberty, we shall find, upon a nearer examination, that it is really confined within very narrow limits, and that all this creative power of the mind amounts to no more than the faculty of compounding, transposing, augmenting, or diminishing the materials afforded us by the senses and experience."[1]

The fact of meaning, as we have already seen, is an empirical fact of experience. Given a problem, if one have any mind at all, he can no more help having suggestions than he can help hearing or seeing. Suggestions just well up naturally. That some sort of suggestions will come is a matter of fact, but *what* suggestions appear depends in part on our native ability and in part on past experience.

The ease with which suggestions arise differs with different people according to their original powers of intelligence. The fertile mind is the one capable of producing easily and readily a great number and variety of suggestions. Alertness,

[1] *An Enquiry Concerning Human Understanding*, pp. 15-16.

ingenuity, and sagacity are the marks of native quickness of mind. Alertness means quickness in seeing vital relationships; it is mental nimbleness, the faculty of possessing just naturally the ability to see alternatives. Sagacity denotes the type of mind that produces profound suggestions. The quality of ideas is more important than the quantity. When, for instance, we say that "knowledge comes but wisdom lingers," we mean that our ideas are trivial and lacking in qualitative richness. Ingenuity belongs to the inventive type of mind, the kind that manipulates and schemes and contrives and experiments. What is suggested in any given case depends in part on these native traits of individual ability.

In the second place, what is suggested in any given instance depends on the past experience and training of the individual. Readiness to respond with the appropriate idea depends on one's familiarity with the facts in question. Prolonged contact with the actual facts and familiarity with a given subject-matter are of chief concern. One who had no experience with an automobile would be helpless in suggesting what to do in case the car came suddenly to stop. One who had no training as an electrician would not know what to do in the case of a short circuit. Problems are solved by

those who are trained in the subject-matter constituting those problems. Native wit can never take the place of experience. When in the face of a difficulty we say, "I have no idea," we mean that the particular problem lies beyond the limits of our experience. Ideas have no existence for the inexperienced and no value for the incompetent.

6. THE ACQUISITION OF IDEAS. Since suggestion is the central factor in thinking, the important practical question is how to stimulate the flow of suggestions. Effective thinking depends on the quantity and quality of ideas. We often speak of the flow of suggestions, of the stream of thought. There are times when the flow becomes a mere trickle and we seem to need a force-pump to produce even that sprinkling. What can be said about increasing the flow?

We cannot by any direct effect of will create suggestions. All that can be done is to accept or reject those that come. There is no such thing as seeing a suggestion before it is offered. There is no power of summoning up ideas as one might send out a search warrant commanding another to appear before him. The following quotation from Charles Dickens is instructive: "As to the way in which these characters [in *Martin Chuzzlewit*] have opened out, that is to me one of the most sur-

prising processes of the mind in this sort of invention. Given what one knows, what one does not know springs up. . . . I don't invent it—really do not—but *see* and write it down." A similar passage may be quoted from Mr. Sanatayana: "My hand, guided by I know not what machinery, is at this moment adding syllable to syllable upon this paper, to the general fulfilment, perhaps, of my felt intent, yet giving that intent an articulation wholly unforeseen, and often disappointing. The thoughts to be expressed simmer half-consciously in my brain. I feel their burden and tendency without seeing their form, until the mechanical train of impulsive association, started by the perusal of what precedes or by the accidental emergence of some new idea, lights the fuse and precipitates the phrases." [1] From this it would seem that there is a fatality attaching to the occurrence of ideas that places their conscious acquisition beyond the power of control. In any given predicament or difficulty we seem simply to trust to the associations of the situation to present us with the appropriate idea. What, then, can be said about the training of thought if the energies of thought are not created by the will of the thinker?

[1] *Life of Reason,* Vol. I, p. 216.

Here as elsewhere the first thing to do is to recognize the problem and to locate as precisely as possible the exact nature of the difficulty. We cannot by an act of mind create suggestions. The method of getting ideas must, therefore, be indirect. It consists in regulating the conditions under which suggestions arise. The following considerations are offered as of practical importance.

(a) *Importance of making a start.* As you begin to explore your subject-matter and to express yourself, one idea will suggest another. What is of importance is that you actually make a start. Write down in a more or less random way all of the things you can think to say about your problem. Then go over them, each one may suggest another, and that another, and so on, until an appropriate idea may be presented. Gradually as you go over your material some manner of arrangement and order will emerge in the course of the procedure, and the way out will become more and more apparent the further you penetrate into the depths of your difficulty. A very good way of beginning the investigation of any new problem is to have a standard set of questions which are more or less applicable to all problems. The questions furnish a means of intellectual approach. They start the mind to work, and even if just mechanically ap-

plied may serve to stimulate the flow of suggestions.

The following illustration taken from the writings of Graham Wallas is an example of a slightly different method of initial approach:

> "A business man who has sat at his desk for a weary hour holding his attention on a simple problem without the least result, will often find his mind full of suggestions the moment he tries to explain his difficulty by word of mouth to a fellow human being; and one of the ways by which a solitary thinker can set his mind to working is to picture to himself the arrival of an intimate friend with the cheery question: 'Now then, what is it that you really want to say?' "

(b) *Mental second wind.* The mind is nearly always sluggish at the start. There is a period of initial resistance to be overcome before suggestions begin to flow. This is analogous to the physical period of warming up. It is easy to get discouraged because results are slow in coming. Overcoming this initial period of despond is one of the most serious obstacles in the way of concentrated and sustained thinking. But it *must* be overcome if there is to be any productive or creative work. The

main thing is to recognize the existence of such a period and to discount it by additional persistence and effort at the start.

(c) *Recording ideas.* Some of our most brilliant ideas come at times when we least expect them. If no record is made of them, they are soon forgotten and no subsequent effort at recall can get them back. Mr. McAdoo says that some of the solutions to his most difficult problems come during the night. He always goes to bed with a notebook in reach. When he wakens up with an idea that has just flashed over his mind, he writes it down before going back to sleep. It is said of Hobbes that his most productive ideas came when he was out walking. Consequently, he used a walking stick with a writing attachment on the end so that he could at any moment sit down and record any ideas that chanced to cross his mind.

(d) *Mental relaxation.* It often happens that ideas do not come when we are tense. It seems as if all of our intellectual energies were being consumed in the *effort* to think rather than in the development of thoughts. Later, when we relax our minds, suggestions begin to come. Every one has had somewhat the following experience. He works hard over a problem, applying all of his intellectual effort and utilizing all of his mental

resources, but to no avail. He gives up in despair. Then suddenly, as if by a miracle of insight, the solution flashes over his mind. Something, we know not what, brings the desired suggestion. Professor James somewhere speaks of the unavailing effort to recall a forgotten name. One exhausts all of his powers of concentration in the attempt to get the name back. Later, when he is not even thinking about his frustrated efforts at recall, the name "comes sauntering into his mind as unceremoniously as if its absence were never in suspicion."

It is important to know that this is one of the ways the mind works and to capitalize it for methodological purposes. It would of course be foolish to say that mental relaxation is the chief way of getting ideas. It would be like saying that the way to think is not to think. The point is mentioned in order to call attention to the trait that the mind has of sometimes working more fruitfully when tensions are relaxed and when pressure is removed. We often, for example, find ourselves quite unable to think when under the strain of an examination. Under the influence of the inhibitions and restraints of the situation, the mind becomes constricted. Later, when the examination is over, and when the tension is released, the mind

resumes its free and spontaneous exercise and then seems to abound in ideas. It was Thackeray who said that he thought of the funny things he might have said at the after-dinner speech later at night when he was preparing for bed.

I cite another quotation from Graham Wallas which illustrates the tendency of the mind to work when released from active effort: "A man, who is reading in order to stimulate his thinking, finds it useful to remain passive for a short time at the end of each chapter, in order to allow his thoughts to continue of themselves. The householder who works at home finds that it pays to stop writing ten minutes before lunch, so as to harvest the last gleanings of his thought, instead of allowing them to present themselves during the meal, and then, having injured both his digestion and his manner, be finally (like 95 per cent of most men's intellectual output) lost through forgetfulness." [1]

The following quotation from Professor Woodworth is a description of the efficacy of mental relaxation as an occasional aid to recall:

> "Drop the matter for a while, and come back to it afresh. Sometimes when you cannot at once recall a name, it does no good to keep doggedly hunting, while half an hour

---

[1] Graham Wallas, *The Great Society*, p. 191.

later you get it without the least trouble. The explanation of this curious phenomenon is found in interference and dying out of interference. At your first attempt to recall the name, you simply got on the wrong track, and thus gave this wrong track the 'recency' advantage over the right track; but this temporary advantage fades out rapidly with rest and leaves the advantage with the track most used in the past.

"The rule to drop a matter when baffled and confused, and take it up again when fresh, can be used in more complex cases than hunting for a name. When, in trying to solve any sort of problem, you find yourself in a rut, about the only escape is to back off, rest up, and make an entirely fresh start."

(e) *Long brooding over the problem.* Suggestions often come after a period of incubation. Sometimes, when we first attempt a solution to a problem, no results are apparent. It is then necessary to keep going over the details, leaving them time to soak in. There is such a thing as unconscious learning. Connections are being formed and associations are developed in the brain which may suddenly come to fruition in the form of just the suggestion needed. It is well to table certain prob-

lems. It takes time for suggestions to ripen; they should be given a chance to mature.

(f) *Speculative attitude of mind.* Perhaps the most important single consideration is the formation of a speculative attitude of mind. One must seek to keep alive his native spirit of curiosity, and to allow his mind to play around a subject. He should do what the child does in playing with a toy; turn it over and look at it from all sides and angles. This means the conscious cultivation of the habit of looking for alternatives. Experience is scintillating with possibilities for those sufficiently gifted with the insight to discern them.

7. DEFINITION. Classification and definition are the two important logical processes in connection with data and meaning. We classify data; we define meanings. Both processes are undertaken in order to facilitate their use in reflection. It is important to make our system of meanings as instructive as possible. This is accomplished by means of definition.

Vagueness of meaning is the mind's original sin. To be able to think clearly about a subject means that the ideas with which we do the thinking must be clear. Ideas are mental tools. A knife to cut clean must have a sharp edge. Decisive thinking, as the word literally means, is clear-cut thinking.

This means that ideas must be clearly defined. To define means to mark off boundary lines, to set limits, to hem in and pin down; it is to fix the meaning of terms. The close thinker is the one who knows where one meaning begins and where it ends, who has the boundary lines of ideas neatly marked off so that he can tell how near to the edge of a meaning he may safely go. If ideas smear and run together, their application to problems is bound to result in confusion.

An intelligent appreciation of a football game, for example, implies a clear understanding of the types of play and the rules governing the game. "Forward pass," "end run," "place kick," "safety," —these are some of the general terms one would have to know in order to be a critical judge of football. To understand the game, one must have a precise and definite knowledge of what these and similar terms mean. If a question were to arise as to whether a "forward pass" had been legitimately played, it could be answered only by one who knows what a forward pass is and the conditions under which it is properly executed. Clear thinking about football presupposes that one has the type forms of play clearly and distinctly defined.

Locke quaintly remarks that "when a man speaks

to another, it is that he may be understood." The communication of meanings and ideas is accomplished through the medium of language. As Hobbes remarks: "The light of the human mind is perspicuous words." Or as expressed by Locke: "For language being the great conduit whereby men convey their discoveries, reasonings, and knowledge, from one to another, he that makes an ill use of it, though he does not corrupt the fountains of knowledge, which are in things themselves; yet he does as much as in him lies, break or stop the pipes whereby it is distributed to the public use and advantage of mankind."[1] It is important, therefore, to have the meanings which are signified by words so definitely fixed that they can be communicated to others without the possibility of misinterpretation. Many of the classical philosophers have written on the use and misuse of words. Thus writes Bacon:

> "The idols of the market are the most troublesome of all, those namely which have entwined themselves round the understanding from the associations of words and names. For men imagine that reason governs words, whilst, in fact, words re-act upon the under-

[1] *Essay,* Book III, XI, 5.

standing; and this has rendered philosophy and the sciences sophistical and inactive. Words are generally formed in a popular sense, and define things by those broad lines which are most obvious to the vulgar mind; but when a more acute understanding, or more diligent observation is anxious to vary those lines, and to adapt them more accurately to nature, words oppose it. Hence the great and solemn disputes of learned men often terminate in controversies about words and names, in regard to which it would be better (imitating the caution of mathematicians) to proceed more advisedly in the first instance, and to bring such disputes to a regular issue by definitions."[1]

So important is the consideration of language as the medium for the communication of meaning that Locke has devoted one out of the four Books of the *Essay Concerning the Human Understanding* to the use and misuse of words. Selections from his writings may prove instructive:

"There are several wilful faults and neglects which men are guilty of in this way of

[1] *Novum Organum,* Aph. LIX.

communication, whereby they render these signs less clear and distinct in their signification than naturally they need be.

"In this kind the first and most palpable abuse is the using of words without clear and distinct ideas; or, which is worse, signs without anything signified. . . . Wisdom, glory, grace, *etc.,* are words frequent enough in every man's mouth; but if a great many of those who use them should be asked what they mean by them, they would be at a stand, and not know what to answer; a plain proof that though they have learned those sounds and have them ready at their tongues' end, yet there are no determined ideas laid up in their minds, which are to be expressed to others by them. . . .

"Secondly, another great abuse of words is inconstancy in the use of them. It is hard to find a discourse written on any subject, especially of controversy, wherein one shall not observe, if he read with attention, the same words (and those commonly the most material in the discourse, and upon which the argument turns) used sometimes for one collection of simple ideas, and sometimes for another; which is a perfect abuse of language: words being intended for signs of my ideas to make

them known to others, not by natural signification, but by a voluntary imposition, it is plain cheat and abuse, when I make them stand sometimes for one thing and sometimes for another; the wilful doing whereof can be imputed to nothing but great folly, or greater dishonesty. . . .

"Thirdly, another abuse of language is affected obscurity, by either applying old words to new and unusual significations, or introducing new and ambiguous terms without defining either; or else putting them so together as may confound their ordinary meaning. . . . This artificial ignorance and learned gibberish prevailed mightily in these last ages, by the interest and artifice of those who found no easier way to that pitch of authority and dominion they attained than by amusing the men of business and ignorant with hard words, or employing the ingenious and idle in intricate disputes about unintelligible terms, and holding them perpetually entangled in that endless labyrinth. Besides, there is no such way to gain admittance or give defence to strange and absurd doctrines, as to guard them round about with legions of obscure, doubtful, and undefined words, which yet make these retreats

more like the dens of robbers or holes of foxes than the fortresses of fair warriors, which, if it be hard to get them out of, it is not for the strength that is in them, but the briars and thorns, and the obscurity of the thickets they are beset in. For untruth being unacceptable to the mind of man, there is no other defense left for absurdity but obscurity." [1]

Locke concludes by saying that if men would only "use the same word constantly in the same sense," "many of the books extant might be spared; many of the controversies in dispute would be at an end; several of those great volumes, swollen with ambiguous words, now used in one sense, and by and by in another, would shrink into a very narrow compass; and many of the philosophers' (to mention no other) as well as the poets' works might be contained in a nutshell."

Among the ancients, Socrates was the first to emphasize the importance of definition as a means of guarding against the ambiguity and obscurity lurking in the meanings employed in ordinary conversation as well as in scientific and philosophical analysis. He was in the habit of entering into conversation with young men and by a skillful use of

[1] *Essay,* III, Chaps. X-XI *passim.*

the question and answer method showing them the inconsistencies and looseness of their thinking. Conversation abounded in the discussion of such topics as "wisdom" and "courage" and "justice" and "virtue," although Socrates soon led men to discover that they really did not know what they meant by any of these terms. Precise definition was for Socrates the first essential of clear thinking. Aristotle says of him: "Socrates . . . fixed thought for the first time on definitions."[1] And again: "For two things may be fairly ascribed to Socrates—inductive arguments and universal definition, both of which are concerned with the starting-point of science."[2]

The following example is an account given by Plato of a conversation between Socrates and a young man named Theaetetus:

"*Socrates.* Take courage then and nobly say what you think that knowledge is.

"*Theaetetus.* Well, Socrates, I will answer as you and he bid me and if I make a mistake, you will be sure to correct me.

"*Soc.* That we will, if we can.

"*Theaet.* Then, I think that the sciences

[1] *Metaphysics*, 987b.
[2] *Ibid.*, 1078b.

which I learn from Theodorus, geometry, and those which you just now mentioned, are knowledge; and I would include the art of the cobbler and other craftsmen: these, all and each of them, are knowledge.

"*Soc.* Too much, Theaetetus, too much; the nobility and liberality of your own nature make you give many and diverse things, when I am asking for one simple thing.

"*Theaet.* What do you mean, Socrates?

"*Soc.* Perhaps nothing. I will endeavor, however, to explain what I believe to be my meaning: When you speak of cobbling, you mean the art of making shoes?

"*Theaet.* That was my meaning.

"*Soc.* And when you speak of carpentering, you mean the art of making wooden implements?

"*Theaet.* Yes.

"*Soc.* In both which cases you define the subjects of the two arts?

"*Theaet.* True.

"*Soc.* But that, Theaetetus, was not the question; we wanted to know not the subject, nor yet the number of the arts or sciences, for we were not going to count them, but we

wanted to know the nature of knowledge in the abstract. Am I not right?

"*Theaet.* Perfectly right.

"*Soc.* Take the following example: Suppose that a person were to ask about some very common obvious thing; shall I say—What is clay? and we were to answer him that there is a clay of potters, there is a clay of ovenmakers, there is a clay of brickmakers; would not that be ridiculous?

"*Theaet.* Truly.

"*Soc.* In the first place, there would be an absurdity in assuming that he who asked the question would understand from our answer the meaning of the word 'clay,' merely because we added 'of the image-makers,' or of any other workers. For how can a man understand the name of that of which he does not know the nature?

"*Theaet.* To be sure he cannot.

"*Soc.* Then he who does not know what science or knowledge is, has no knowledge of the art or science of making shoes?

"*Theaet.* None.

"*Soc.* Nor of any other science?

"*Theaet.* No.

> "*Soc.* And when a man is asked 'what science or knowledge is,' to give as an answer the name of some art or science is ridiculous; for the question is, 'What is knowledge,' and he replies 'a knowledge of this and that.'"

Theaetetus was attempting to make a definition in terms of sense data, and sense data are always particular examples, and no illustration of a thing is ever a definition of it. Socrates rightly sees that a thing must be defined in terms of a concept. Now concepts are generalized or standardized meanings. When once the general meaning is acquired, we have something in terms of which all the scattered and particular data can be understood. Socrates was the first to discover the concept and to make it the basis of definition. That is to say, a definition must be formulated in terms of meaning, and not in terms of data. Socrates' method of formulating definitions was as follows: A beginning is made by collecting a number of instances. An examination of these instances reveals that they are all possessed of a common element. The element common to them all is then read out of the instances and made the basis of a definition. The concept or generalized meaning is therefore arrived at inductively.

The technique of formal definition is exceedingly simple. It consists in placing the term to be defined into the class to which it belongs (technically termed *genus*) and adding the characteristic mark which distinguishes it from the other members of the class (technically termed *differentia*). For example, take the Aristotelian definition of man as a rational animal. "Animal" is the *genus* (class concept), in which man is placed; "rationality" is the *differentia* which distinguishes man from other animals. The *differentia* is the *fundamentum divisionis* of a dichotomous division. The class "animal" is divided into men and non-men, "rationality" being used as the principle of the division. It should be noted that the *differentia* is usually selected with reference to the purpose one has in expounding the meaning of a term.

Logicians are accustomed to formulating certain rules which should be observed in making definitions. They are usually given as follows: (1) A definition should state the essential attribute of the thing to be defined; (2) a definition should not contain the name to be defined, nor any word which is directly synonymous with it; (3) the definition should be exactly equivalent to the class of objects defined; that is, it must be neither too broad nor too narrow; (4) a definition should not be ex-

pressed in obscure, figurative, or ambiguous language; (5) a definition should, whenever possible, be affirmative rather than negative.

The above rules apply to what in logic are termed *formal* definitions. There are, however, other useful ways of defining than by means of *genus* and *differentia.* We often gain a clearer understanding of the meaning of a thing by telling what it is for than by telling what it is. A definition which is framed in terms of purpose or use is technically called a *teleological* definition. This form of definition is especially useful in biology. The organs of the body are explained in terms of their function. We tell what things are by telling what they do. A third form of definition is encountered when the attempt is made to explain things in terms of the way they have been produced or derived. This is usually termed *genetic* definition. These three forms of definition will be treated more fully when we come to the chapter on Explanation.

QUESTIONS

1. Explain the distinction between observation and inference.

2. What is meant by "the inferential element" in perception? Is this the same as the "intellectual element" in non-reflective experience?

3. Distinguish between the verbal and substantive connotation of the word inference.

4. Develop as fully as you can the meaning of "mental."

5. What are the two meanings of meaning?

6. Define intuition.

7. Explain the non-logical character of intrinsic meanings.

8. Explain the dual rôle played by intrinsic meanings.

9. What is a concept? Distinguish conception from concept, and perception from percept.

10. How is the generality of a concept to be conceived?

11. Define "indication" and "implication."

12. What is meant by saying that implication is the heart of reasoning?

13. Define "idea" and distinguish ideas from meanings.

14. Explain Plato's doctrine that knowledge is recollection. What problems does this doctrine solve?

15. For what purpose are the quotations from Locke, Hobbes, and Hume introduced? Discuss fully.

16. "The method of getting ideas is indirect." Explain.

17. State and discuss each of the practical considerations offered as means of stimulating the flow of ideas.

18. Summarize Locke's discussion of the misuse of words.

19. What do you learn about definition from the quotation taken from the *Theaetetus?*

20. Distinguish definition from illustration, and from description.

21. How does definition differ from classification?

22. Describe the Socratic method of arriving at definitions. Why is it called inductive?

23. State the requirements of a good definition.

24. What forms of definition are useful other than formal definition? Explain each type.

25. How is the *essential* attribute appearing in a formal definition determined? Has anything an essential attribute

apart from human purposes? What light does your answer to this question throw on the matter of definitions?

ILLUSTRATIONS

1. Give illustrations of intrinsic meanings.
2. Illustrate the practical rôle played by intrinsic meanings.
3. Give an illustration of an esthetic experience.
4. Illustrate perceptual and conceptual inference.
5. Give illustrations of concepts.
6. Illustrate the three functions of meanings described by Dewey on page 174.
7. Give an illustration to show that implication is the heart of reasoning.

EXERCISES

1. Develop as fully as you can the distinction between the realm of *existence* and the realm of *essence*.
2. Develop as fully as you can the statement that the distinction between the physical and the mental, body and mind, is a logical distinction.
3. Have meanings any existence outside the context of reflection?
4. Discuss the statement: An unmeant meaning is meaningless. Relate to the foregoing question.
5. Are all perceptual inferences of logical significance? If not, how do you distinguish those which are and those which are not?
6. Develop the statement: Indication is a natural event.
7. What truth, if any, attaches to the statement of Chevreul, the French scientist, that "Every fact is an abstraction"?
8. Give an interpretation of Schopenhauer's analysis of an esthetic experience. Give special attention to the two figures of speech used in the second quotation.

9. Is the difference between intrinsic and extrinsic meanings a difference in kind, or quality? What is the principle in terms of which the distinction is made?

10. Can we have knowledge in terms of meanings alone?

11. Does mathematics deal exclusively with relations of implication?

12. Analyze the following examples, point out the data, the concepts (generalized meanings), the indications, the implications, and state whether you think the inferences are true or false or doubtful:

a. There should be no restriction of debate in the United States Senate because freedom of speech is one of our most sacred privileges.

b. A fortunate glance at a broken sheep's skull, which Goethe found by accident on the sand of the Lido at Venice, suggested to him that the skull itself consisted of a series of very much altered vertebrae.

c. No man should be punished if he is innocent. This man is innocent and should, therefore, not be punished.

d. This man is a Protestant, for he exercises the right of private judgment.

e. When young Galileo was a student at Pisa, he noticed one day during the service at the great Cathedral the chandelier swinging backwards and forwards, and convinced himself by counting his pulse that the duration of the oscillations was independent of the arc through which it moved.

13. Formulate definitions of the following terms: logic (in the sense of being a branch of study), undisciplined imagination, reflective thinking, belief, evidence, habit, instinct, datum, meaning, idea, perception, observation, concept, indication, implication, intrinsic meaning, extrinsic meaning.

CHAPTER SEVEN

REASONING

Reflection occupies an intermediary position in experience, and fulfills an instrumental function. Its temporal placing is in between a problem and its solution. As an intervening operation it is characterized by two logically distinct phases: 1. Data and meaning; and 2. Reasoning. The resolution of the gross total situation into what is there in the way of factual resources and obstacles, and the body of interpretative material suggested and projected as possible though tentative means of explanation, marks the first phase. This distinction yields the materials of reflection. Data and meanings are the factors in terms of which further thinking goes on. The ascertainment of data and the importation of meaning serve to formulate the problem and to put one on the track of a solution.

But, although suggestions and ideas (meanings) present themselves *for* consideration, they do not consider themselves. The consideration given to meanings is a subsequent operation. Suggestions

of themselves afford no guarantee of their reliability. As a suggestion it is only a proposal; it may be a mere guess or a conjecture. Ideas are candidates for belief without the necessary grounds for belief. Reliability and trustworthiness are things which have to be determined. The operation by means of which this is accomplished may be termed reasoning. Reasoning may be defined as the more extensive elaboration of data and the further development of meanings in their relations to each other. This operation constitutes the second and more advanced phase of reflection.

It should be remembered, however, that the two phases of reflection, data and meaning, on the one hand, and reasoning on the other, are two continuous and interpenetrating processes. The distinction is logical rather than chronological. Reasoning marks an advanced phase of reflection and, since it goes on in terms of data and meaning, is not numerically distinct from it. It is a process in which data are further elaborated, selected, and eliminated, and in which meanings are developed, modified and extended, with the final outcome in mind of finding a meaning which will be an adequate interpretation of the final listing of the facts. Remembering, then, that reasoning is only an advanced stage in which data and meaning are fur-

ther developed in their interrelation, we may proceed to its logical analysis.

1. Reasoning As An Inquiry. A man traveling through an unfamiliar country comes to the cross-roads. In the absence of any sign-posts indicating direction, he suddenly comes to a stop. Which is the right road? If he is just traveling for pleasure he probably does not care which way he goes. But if he has an objective in view, some definite place to go to, it makes a great deal of difference which road he takes. Confronted with this situation, he must make some decision. And this may be one of two kinds. He may guess at the right road and trust to luck to come out right; or, he may attempt to discover some evidence that will assist him in making his decision. At this point reflection emerges as a means of guiding and controlling the situation. The traveler stops to take his bearings. He studies the conditions of the roads; he reverts to his general sense of direction; he looks for a house where he may go and make an inquiry; he attempts to extract from these facts some evidence that will guide his decision. In however simple a fashion he has resolved the situation into data (condition of the roads, *etc.*) and meaning, and if his thinking progresses further, he uses the elements of this distinction as means to further thinking (reasoning).

To reason, therefore, is to investigate a suggestion before accepting or rejecting it. It is to institute an inquiry as to the standing of an idea. What is the evidence for it? What are its credentials? What are the grounds which support it and what are the consequences which follow from it? To reason is to turn the idea over in mind, to look at it from all angles, to debate with it, to run it out, to search for additional evidence that will either bear it out or show its inadequacy. It is important that every suggestion be a *tested* suggestion, that every idea be judged in terms of its relative value and validity. To reason is to deal deliberately with a problem; it is to put conscious intention in the place of habit and to substitute the method of inquiry for the method of guessing. It is an active and constructive process in which the attempt is made to discover, select, arrange, invent, develop, test, and apply ideas as means to ends.

The two following quotations, one from Professor Woodworth, and the other from Professor Dewey, are descriptions of the reasoning process:

> "Reasoning might be described as mental exploration, and distinguished from motor exploration of the trial and error variety. Suppose you need a hammer and go to the place where it is kept, only to find it gone. Now if

you simply proceed to look here and there, ransacking the house without any plan, that would be motor exploration. But if, finding this trial and error procedure to be laborious and almost hopeless you sit down and think, 'Where can that hammer be? Probably where I used it last,' you may recall using it for a certain purpose, in a certain place; go there and find it. You have substituted mental exploration of the situation for purely motor exploration, and saved time and effort. Such instances show the use of reasoning, and the part it plays in behavior. . . . It is an exploratory process, a searching for facts. In a way it is a trial and error process. If you don't ransack the house, at least you ransack your memory, in search for the facts that will assist you. You recall this fact, and that, you turn this way and that, mentally, till some fact is recalled that serves your need."[1]

"We begin with a summary assertion that deliberation is a dramatic rehearsal in imagination of various competing possible lines of action. It starts from the blocking of efficient overt action, due to that conflict of prior habit and newly released impulse to which reference

[1] R. S. Woodworth, *Psychology*, pp. 462-3.

has been made. Then each habit, each impulse, involved in the temporary suspense of overt action takes its turn in being tried out. Deliberation is an experiment in finding out what the various lines of possible action are really like. It is an experiment in making various combinations of selected elements of habits and impulses, to see what the resultant action would be like if it were entered upon. But the trial is in imagination, not in overt fact. The experiment is carried on by tentative rehearsals in thought which do not affect physical facts outside the body. Thought runs ahead and foresees outcomes, and thereby avoids having to await the instruction of actual failure and disaster. An act tried out is irrevocable, its consequences cannot be blotted out. An act tried out in imagination is not final nor fatal. It is retrievable."[1]

2. THE TWO PARTS OF AN INQUIRY. Reasoning, as we have seen, takes the form of an inquiry. Let us now seek to analyze the nature of an inquiry more precisely. Every inquiry breaks up into two distinct parts. First, we inquire in order to get additional information. This is the phase of dis-

[1] J. Dewey, *Human Nature and Conduct*, p. 190.

covery; the projecting of some method or methods of dealing with the difficulty, the formulation of explanatory conceptions, or in more elaborate cases, a period of hypothesis making. But this is only half of the process. The second part of an inquiry involves testing the interpretative conceptions tentatively formulated. This is the phase of proof or verification. Before accepting a plan of action, it must be approved; before committing oneself to a policy, it must be verified.

This distinction may be expressed in another way. Any suggestion or meaning which is tentatively entertained as a possible solution to a problem has been called an *idea*. When confronted with a situation which is confused and unclear, one seeks to discover a point of view from which it may be seen in a new light. Ideas are points of view from which to look at a problem. Two distinct operations are involved: first, getting a point of view; and secondly, viewing from that point. In all reasoning there is a double movement, a movement from the facts in the case (data) to the idea; and a movement from the suggested meaning back to the facts, a *backward* movement to see if the idea really does throw light on the confused data. The forward movement, a movement from data to meaning, involves discovery; the backward move-

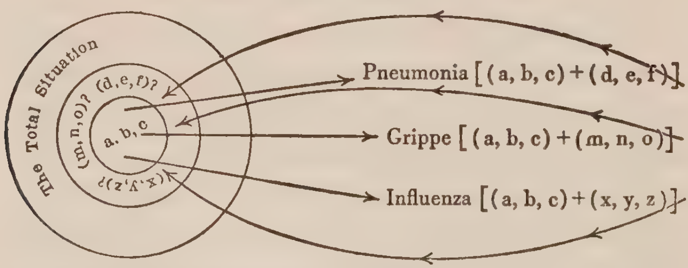
ment, a movement from meaning to data, involves proof.

As a physician examines a patient, certain obvious symptoms, *a, b, c,* are first observed. Out of these facts of observation (data) some explanation must be formed. The symptoms, *a, b, c,* let us say, indicate grippe, influenza, and pneumonia. Each of these is a tentative explanation, a possible solution to the problem of diagnosis. There is here a forward movement, a movement from symptoms (data) to the three suggested causes (meanings). The physician has formulated three points of view from which he may further examine the patient. He may view the patient as a grippe, as an influenza, or as a pneumonia patient.

Having derived these three ideas, the physician then proceeds to *test* them. Is this pneumonia? The physician has presumably met with pneumonia many times before in his practice. Pneumonia is a standardized meaning, a concept which is a part of a physician's system of interpretative material. He knows that pneumonia means *a, b, c,* plus *d, e, f.* A casual observation brought out *a, b, c,* and these data suggest pneumonia as a possible cause; but what about *d, e, f?* If this is a case of pneumonia, then (a conceptual inference from a general meaning to what it implies) these addi-

tional facts ought to be present. The physician then goes from the concept pneumonia (*a, b, c, d, e, f*) back to the facts of the case to see *if d, e, f* are present. This is the backward movement from meaning to data. It should be noted that the backward movement is not just back to *a, b, c;* it is back to the facts in search of more facts (*d, e, f*) which will substantiate or nullify the pneumonia hypothesis. If upon further examination, *d, e, f* are not found, it is concluded that the pnuemonia idea throws no light on the case. It is discarded and another hypothesis (suggestion, meaning, idea) is taken up for consideration.

We may represent the double movement in reflection by the following diagram:



The two movements of reflection are as follows:

Forward Movement	*Backward Movement*
Discovery	Proof, testing, verification
From data to meaning	From meaning to data

In logic these two operations are technically termed induction and deduction. Reflection involves both processes; it is a sort of shuttle-like movement from a problem to some tentative explanatory conception and from that conception back to the initial facts to see if the proposed solution has any explanatory value. It is a kind of "cut and try" procedure. First, you cut to get things into shape, and then you try to see if they fit. Inductive discovery is the cutting; deductive proof is the fitting. In any concrete case of thinking the two processes are continuous. They can be separated only for analysis and description.

3. IMPLICATION THE ESSENTIAL TRAIT OF REASONING. Reverting to the distinction made between perceptual and conceptual inference, and the use of the terms indication and implication to stand for the two types of inference, we may now point out that only inferences involving implication are properly constitutive of reasoning. The symptoms, *a, b, c,* in the above illustration indicate pneumonia; but if the pneumonia idea is at once accepted, it cannot be said that there has been any reasoning. It is only when the concept, pneumonia, has been used as a basis of implication, and when *its* meanings have been employed as middle terms in further reflection that there can be said to have been reasoning.

Perceptual inference, therefore, is not reasoning. Professor James, though not using these terms, arrives at the same conclusion:

> "Much of our thinking consists of trains of images suggested one by another, of a sort of spontaneous reverie of which it seems likely enough that the higher brutes should be capable. This sort of thinking leads nevertheless to rational conclusions, both practical and theoretical. . . . As a rule, in this sort of irresponsible thinking, the terms which fall to be coupled together are empirical concretes, not abstractions. A sunset may call up the vessel's deck from which I saw one last summer, the companions of my voyage, my arrival into port, *etc.,* or it may make me think of solar myths, or Hercules' and Hector's funeral pyres, of Homer and whether he could write, of the Greek alphabet, *etc.* . . . But the thought as a rule is of matters taken in their entirety. Having been thinking of one, we find later that we are thinking of another, to which we have been lifted along, we hardly know how. If an abstract quality figures in the procession, it arrests our attention but for a moment, and fades into something else; and is never very abstract. . . .

"The upshot of it may be that we are reminded of some practical duty; we write a letter to a friend abroad, or we take down the lexicon and study our Greek lesson. Our thought is rational, and leads to a rational act, but it can hardly be called reasoning in a strict sense of the term. . . ."

Of this "non-conceptual ideation" (or what we term perceptual inference) Professor James further remarks:

"But the idea in question is of an object *about* which nothing farther may be articulately known [that is, no implications are deduced from it]. The thought of it prompts to activity, but to no theoretic consequences [implications]." [1]

The following is Professor James' description of reasoning. Its essential mark will be seen to be implication:

"In reasoning, *A* may suggest [indicate] *B;* but *B,* instead of being an idea which is simply *obeyed* by us, is an idea which suggests [implies] the distinct additional idea *C*. And where the train of suggestion is one of reasoning distinctively so called as contrasted with mere reverie or 'associative' sequence, the ideas

[1] *Psychology*, Vol. II, 325-326.

bear certain inward relations to each other which we must proceed to examine with some care [implication].

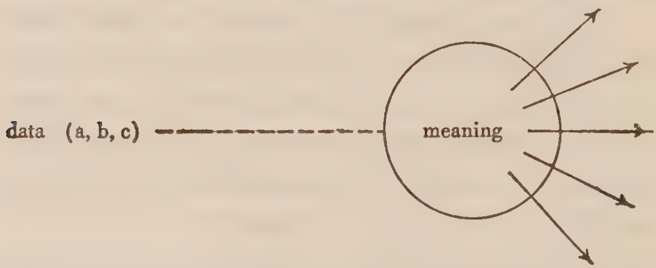
"The result *C* yielded by a true act of reasoning is apt to be a thing voluntarily *sought,* such as the means to a proposed end, the ground for an observed effect, or the effect of an assumed cause. All these results may be thought of as concrete things, but they are not *suggested immediately by other concrete* things, as in the trains of simply associative thought. They are linked to the concretes which precede them by intermediate steps, and these steps are formed by *general characters* articulately denoted and expressly analyzed out. A thing inferred by reasoning need neither have been an habitual associate of the datum from which we infer it, nor need it be similar to it. It may be a thing entirely unknown to our previous experience, something which no simple association of concretes could ever have evoked. The great difference, in fact, between that simpler kind of rational thinking which consists in the concrete objects of past experience merely suggesting each other, and reasoning distinctively so called, is this, that whilst the empirical thinking is only reproductive, reasoning is productive. An

> empirical, or 'rule-of-thumb,' thinker can deduce nothing from data with whose behavior and associates in the concrete he is unfamiliar. But put a reasoner amongst a set of concrete objects which he has neither seen nor heard of before, and with a little time, if he is a good reasoner, he will make such inferences from them as will quite atone for his ignorance. Reasoning helps us out of unprecedented situations—situations for which all our common associative wisdom, all the 'education' which we share in common with the beasts, leaves us without resource.
>
> "Let us make this ability to deal with NOVEL data the technical differentia of reasoning. This will sufficiently mark it out from common associative thinking [perceptual inference], and will immediately enable us to say what peculiarity it contains." [1]

The "novel" to which reference is here made corresponds to the deduction made by implication. For example, in the above illustration, the data, *a, b, c,* were given. They indicate pneumonia. But the concept, pneumonia, implies *d, e, f*. Now *d, e, f* are the *novel* elements. They were not given at the start. They were first implied in the con-

[1] *Psychology,* Vol. II, pp. 329-330.

cept and discovered *after* their implication. If I pass from *a, b, c,* to the idea, pneumonia, and without drawing any implications from that idea, pass back to the original data, I have just what I started with, namely, *a, b, c.* This would be a circular process in which there would be nothing new, no intellectual advance, no reasoning. But when I tarry with the concept, and deduce its theoretical implications, I then have new facts, *d, e, f,* to look for. Implication, therefore, is the intellectual operation which renders ability to deal with the novel possible. It marks the essential feature of reasoning. Consider the following diagram:



The arrows stand for the implication deduced from the meaning. The function of implications is to enlarge the field of vision, to introduce new terms into the reflective process, and by so doing to increase one's grip on the original problem. Where this intervening step of conceptual development is absent, there is no reasoning.

4. Interrelation of Induction and Deduc-

TION. Although implication is the essential trait of reasoning, and although perceptual inference taken by itself is not reasoning, it does not follow that reasoning should be treated exclusively as dealing with implication. There can be no reasoning without implication, but implication is not the whole of reasoning. There must be concepts from which deductions are made before one can proceed to deduce them. The discovery and formulation of these concepts is an integral part of reasoning and marks its inductive phase. That is to say, reasoning does not take its start in the middle of reflection, but has its origin in the total problematic situation. In the foregoing illustration, for example, we do not reason about pneumonia or influenza, but about the nature of the illness.

Reasoning takes the form of an inquiry, and an inquiry is characterized by an inductive and a deductive phase. For purposes of description, it will be necessary to separate these two phases and discuss each separately. But such a separation is external to the thought process. Any serious and thoughtful investigation of a difficult and complicated problem involves a series of processes the order of which is determined by the specific character of the investigation. One may observe, draw perceptual inferences (induction), from these deduce implications (deduction), and then, guided

by the demands of thought, go back and make further observations. From this added perceptual material he may make additional inferences (further induction) and from these deduce more implications. The purpose of conceptual inference is to guide observation in bringing to light new facts which in turn lead to further perceptual inferences. In so far as the derived perceptual inferences lead to modification and revisions of the original meanings, they may be taken as integral parts of the reasoning process. It seems incorrect, then, to speak of inductive reasoning, or of deductive reasoning; each marks a phase of a process that is single and indivisible. No hard and fast rules can be laid down for the order in which the two phases occur. But it seems obvious that the order in which they are described need not be the order in which they actually occur. This is equivalent to saying that the order in which they are discussed is a methodological and not a logical order.

The movement of thought is a series of flights and perchings. During the intervals between the flights, thought reconnoiters, as it were, takes an inventory of its theoretical resources before attempting further flight. Induction is the account of the flights, deduction of the perchings. The total thought movement involves both.

QUESTIONS

1. How are the two stages in reflection, the data and meaning stage and the reasoning stage, distinguished, and how are they related?

2. Would it be correct to look upon data and meaning as the *elements* of reflection, and reasoning as the *relations* of the elements?

3. Is there any contradiction in the following statements: reasoning as a stage in reflection is distinguished from data and meaning; induction is a phase of reasoning; induction includes the logical processes connected with data and meaning?

4. Define reasoning.

5. Can you suggest a more limited use for the term reasoning than the one given in the text?

6. Give a description of reasoning as (1) a form of inquiry; (2) as mental exploration; (3) as imaginative rehearsal.

7. Arrange the following terms into two groups: discovery, backward movement of thought, proof, induction, deduction, forward movement of thought, from meaning to data, from data to meaning, testing, verification.

8. Explain the meaning of induction and deduction.

9. Give an interpretation of the diagram on page 218.

10. Make a careful logical analysis of the quotations from James given on pages 219 *seq.* Fit the distinctions there made into the terminology given in the text.

11. Explain fully the statement: "Let us make this ability to deal with NOVEL data the technical differentia of reasoning."

12. Explain fully what is meant by "novel."

13. What is the function of implication in reflection?

14. Upon what does the ability to deduce implications from a concept depend?

15. Is it possible to have inductive reasoning without deduction? Discuss fully.

ILLUSTRATIONS

1. Illustrate reflection as (1) a form of inquiry; (2) as mental exploration; (3) as imaginative rehearsal.

2. Construct an example to show the backward and forward movements of thought.

3. Construct an example to illustrate the manner in which reasoning deals with the novel.

4. Construct an example to illustrate the continuity and interrelation of induction and deduction.

EXERCISES

1. Relate the following definition of implication to the discussion given in the text: "This relation of implication has been defined as that which holds between two propositions when the denial of the second is inconsistent with the truth of the former."

2. Criticise the following: "Man is higher biologically than any of the other animals because he is individually capable of more diversified living. This, of course, implies greater structural as well as physiological complexity. . . ." (C. J. Herrick, *Neurological Foundations of Animal Behavior,* p. 14.)

3. "Ignorance leads to superstition." State in a series of propositions all the implications of this assertion.

4. "Women write the best letters, and have the best letters written to them." State in a series of propositions all the implications of these assertions.

5. Assuming the truth of the following statement: All just acts are expedient acts; and assuming that all acts are either just or unjust, and that they are either expedient or inexpedient, state in a series of propositions all the implications, both affirmative and negative, that can be drawn about just and unjust acts, and about expedient and inexpedient acts.

6. Can you tell by what logical right you draw the implications in the three foregoing questions?

7. The following exercise should be attempted by only the most competent students. The exercise consists in understanding the following passage and in relating the distinctions to the discussions in the text:

"In all judgments in which there is a relation between subject and predicate, that relation can be of two kinds. Either the predicate *B* belongs to the subject *A* as something contained (though covertly) in the concept *A;* or *B* lies outside the sphere of the concept *A,* though somehow connected with it. In the former case, I call the judgment analytical, in the latter synthetical. Analytical judgments are therefore those in which the connection of the predicate with the subject is conceived through identity, while others in which that connection is conceived without identity may be called synthetical. The former might be called illustrating, the latter expanding judgments, because in the former nothing is added by the predicate to the concept of the subject, but the concept is only divided into its constituent concepts which were always conceived as existing within it, though confusedly; while the latter add to the concept of the subject a predicate not conceived as existing within it, and not to be extracted from it by any process of analysis. If I say, for instance, All bodies are extended, this is an analytical judgment. I need not go beyond the concept connected with the name of body, in order to find that extension is connected with it. I have only to analyze that concept and become conscious of the manifold elements always contained in it in order to find that predicate. This is therefore an analytical judgment. But if I say, All bodies are heavy, the predicate is something quite different from what I think as the mere concept of body. The addition of such a predicate gives us a synthetical judgment.

"It becomes clear from this

"(1) That our knowledge is in no way extended by analytical judgments, but that all they effect is to put the concepts which we possess into better order and render them more intelligible.

"(2) That in synthetical judgments I must have besides the concept of the subject something else (x) on which the understanding relies in order to know that a predicate, not contained in the concept, nevertheless belongs to it.

"In empirical judgments this causes no difficulty, because this x is here simply the complete experience of an object which I conceive by the concept A, that concept forming one part only of my experience. . . . Experience, therefore, is the x which lies beyond the concept A, and on which rests the possibility of a synthesis of the predicate of gravity B with the concept A.

"In synthetical judgments *a priori*, however, that help is entirely wanting. If I want to go beyond the concept A in order to find another concept B connected with it, where is there anything on which I may rest and through which a synthesis might become possible, considering that I cannot have the advantage of looking about in the field of experience?"[1]

[1] Kant, *The Critique of Pure Reason*, Eng. tr., E. Max Müller, pp. 5-7.

CHAPTER EIGHT

TYPES OF INQUIRY

Reasoning, we have just seen, takes the form of an inquiry. In the present chapter, largely for the purpose of illustration and analysis, we shall cite examples of five types of inquiry. These we shall term deliberative exposition, deliberative selection, deliberative discovery, deliberative invention, and deliberative reconstruction. In exposition the problem is to present what is unclear and abstruse in terms that are simpler and better known. In selection the problem is to choose between alternatives which exist and are given. In discovery, the *quaesitum* exists, but is not given, the problem being to find it. In invention, the *quaesitum* neither exists nor is given, and the problem is to create it. In revision, the problem is concerned with the modification and reconstruction of ideas with a view to a more effective adaptation to circumstances. It is not meant that these five types of inquiry are entirely separate; they overlap and interpenetrate; nevertheless they serve to define specialized types of problems.

1. Deliberative Exposition. Explanation, for the most part, consists in describing what we do not know in terms of what is already known. The basis of this description lies in the character of resemblance. As soon as the unknown is related to the known by the tie of similarity, we carry over our knowledge about the known and apply it to the unknown. This form of procedure may be termed analogy. Analogy is one of the most useful and at the same time one of the simplest means of intellectual advance. The principle of analogical inference may be stated as follows: Two things are alike in certain important features; a proposition is known to be true of one, it is then inferred that it is true of the other. Consider the following example:

"We should think it a sin and a shame if a great steamer dashing across the ocean were not brought to a stop at a signal from the mere smack. . . . And yet a miner is entombed alive, a painter falls from a scaffold, a brakeman is crushed in coupling cars, a merchant fails, falls ill, and dies, and organized society leaves widow and child to bitter want or degrading alms."[1] In this example, the relation between organized society and its individ-

[1] Quoted from Henry George, *Protection and Free Trade*, by B. H. Bode, *An Outline of Logic*, p. 306.

ual members is like the relation between a great steamer and a mere smack. The proposition that it would be a sin and a shame for the great steamer not to heed the distress signal of the mere smack is known to be true. It is then inferred that organized society should come to the rescue of any of its distressed members.

In this illustration analogy is made the basis of argumentation. But it should be carefully noted that analogy is not proof. So dangerous and incomplete are arguments from analogy, that its logical use should be restricted to the following: (1) exposition; and (2) fruitfulness of suggestion. The second use means that analogy encourages ideas and in more elaborate cases becomes suggestive of explanatory hypotheses. This use of analogy will be discussed more fully in connection with the guidance of induction.[1] In the present chapter we are concerned chiefly with analogy as a form of deliberative exposition. The following passage from Descartes illustrates the use of analogy in describing the mechanical way in which bodily functions are explained by the action of the animal spirits:

"In proportion as these spirits enter the

---

[1] See p. 280 below.

cavities of the brain, they pass thence into the pores of its substance, and from these pores into the nerves; where, according as they enter or even only tend to enter, more or less, into one than into another, they have the power of altering the figure of the muscles into which the nerves are inserted, and by this means of causing all the limbs to move. Thus, as you may have seen in the grottoes and the fountains in royal gardens, the force with which the water issues from its reservoir is sufficient to move various machines, and even to make them play instruments, or pronounce words according to the different disposition of the pipes which lead the water.

"And, in truth, the nerves of the machine which I am describing may very well be compared to the pipes of these waterworks; its muscles and its tendons to the other various engines and springs which seem to move them; its animal spirits to the water which impels them, of which the heart is the fountain; while the cavities of the brain are the central office. Moreover, respiration and other such actions as are natural and usual in the body, and which depend on the cause of

the spirits, are like the movements of a clock, or of a mill, which may be kept up by the ordinary flow of the water.

"The external objects which, by their mere presence, act upon the organs of the senses; and which, by this means, determine the corporal machine to move in many different ways, according as the parts of the brain are arranged, are like the strangers who, entering into some of the grottoes of these waterworks, unconsciously cause the movements which take place in their presence. For they cannot enter without treading upon certain planks so arranged that, for example, if they approach a bathing Diana, they cause her to hide among the reeds; and if they attempt to follow her, they see approaching a Neptune, who threatens them with his trident; or if they try some other way, they cause some other monster, who vomits water into their faces, to dart out; or like contrivances, according to the fancy of the engineers who have made them. And lastly, when the *rational soul* is lodged in this machine, it will have its principal seat in the brain, and will take the place of the engineer, who ought to be in that part of the works with

> which all the pipes are connected, when he wishes to increase, or to slacken, or in some way to alter their movements." [1]

2. DELIBERATIVE SELECTION. This type of inquiry may be readily identified. The problem is to choose between alternative courses of action, when the alternatives are already given. What University shall I attend? What courses shall I select? What religion shall I embrace? What political party shall I join? What candidate shall I vote for? In all these cases, the alternatives are given and the problem of reflection concerns the wise choice between them. Problems of this sort are so numerous that one may say that the main business of life is to choose between alternative courses of action.

The following passage is adapted from Plato's *Republic* and emphasizes the importance of choice in practical life. In the form of a myth he tells a tale of Er, the Pamphylian.

> "He was slain in battle, and ten days afterwards when the bodies of the dead were brought in, already in a state of corruption, he was brought in with them undecayed, and car-

[1] Quoted from Descartes' *Traite de l'Homme* (Cousin's edition), p. 347, by T. H. Huxley, *Method and Results*, Lecture IV.

ried home to be buried. And on the twelfth day, as he was lying on the funeral pyre, he returned to life and told them what he had seen in the other world. The spirits arriving in the other world must under the direction of the three Fates, choose their lots for a new life.

"Hear the words of Lachesis, the daughter of Necessity. Mortal souls, behold a new cycle of mortal life. Your genius will not choose for you, but you will choose your genius; and let him who draws the first lot have the first choice of life, which shall be his destiny. Virtue is free, and as a man honors or dishonors her he will have more or less of her; the chooser is answerable. . . . And this . . . is the great danger of man; and therefore the utmost care should be taken. Let each one of us leave every other kind of knowledge and seek and follow one thing only, if peradventure he may be able to learn and find who there is who can and will teach him to distinguish the life of good and evil, and to choose always and everywhere the better life as far as possible. He should consider the bearing of all these things which have been mentioned severally and collectively upon a virtuous life; he should know what the effect of

beauty is when compounded with poverty or wealth in a particular soul, and what are the good and evil consequences of noble and humble birth, or private and public station, of strength and weakness, of cleverness and dullness, and of all the natural and acquired gifts of the soul, and study the composition of them; then he will look at the nature of the soul, and from the consideration of all this he will determine which is the better and which is the worse life, and at last he will choose, giving the name of evil to the life which will make his soul more unjust, and good to the life which will make his soul more just. . . . Let not the first be careless in his choice, and let not the last despair."[1]

"Er concludes with the following comment: "Most curious was the spectacle of the election—sad and laughable and strange."

The following is an illustration of deliberative selection:

"A student may, for example, be seated at his study, preparing for an examination. A friend enters and suggests going for a walk or to the theater. If the student were to follow

[1] *Republic*, Bk. X, 618.

this first immediate impulse he would, before he realized it, be off on an evening's entertainment. But instead of responding immediately, dropping his books, reaching for his hat, opening the door, and ringing for the elevator (a series of habitual acts initiated by the instinctive desire for rest, variety, and companionship), he may rehearse in imagination the various possibilities of action. In general terms, what happens is simply this:

"On the one hand, the gregarious instinct, the desire for rest, native curiosity, and an acquired interest in drama may prompt him strongly to go to the theater. On the other hand, the habits of industry, ambition, self-assertion, and studying in the evening urge him to stay at home and study. The first course of action may, for the moment, be immediately attractive and stimulating. But instead of responding to either immediately, the student rehearses dramatically the possibilities associated with each. On the one hand are the immediate satisfactions of rest, amusement, and companionship. But as further consequences of the impulse to go out to the theater are seen, or rather are foreseen, failure in the examination, the loss of a scholarship, pain to

one's family or friends, and chagrin at the frustration of one's deepest and most permanent ideals. The second course of action, to stay at home and study, though it is seen to have connected with it certain immediate privations, is foreseen to involve the further consequences of passing the examinations, keeping up one's scholarship, and maintaining certain personal or intellectual standards one has set for one's self. The student goes out fully aware of the consequences of what he is doing; he goes *for* the immediate pleasure and *in spite of* the possible failure in the examination. The very heart of reflective behavior is thus seen to lie in the fact that present stimuli are reacted to, not for what they are as immediate stimuli, but for what they signify, portend, imply, in the way of consequences or results. And a response made upon reflection is made on the basis of these imaginatively realized consequences. We connect what we do with the results that flow from the doing, and control our action in the light of that prophetically realized connection."[1]

3. DELIBERATIVE DISCOVERY. A third type of

[1] Edman, *Human Traits*, pp. 49-51.

inquiry is to be found in the discovery of causes. Both in practical deliberation and in scientific research, knowledge of causes is the goal of inquiry and investigation. Discovery and assignment of causes are an important step in the direction of explanation. A thing is said to be explained when we can assign "the reason why." For example, why was the candidate defeated in the election? What caused the fire? Why did he fail in the examination? These and similar questions which arise every day in practical experience express a desire to understand the causes in terms of which actions and events are to be explained. Search for causes is the major aim of science. What is the cause of the formation of dew? What is the cause of earthquakes? Why is the earth's orbit an ellipse? These phenomena are understood when I know their causes.[1]

Knowledge of causes involves two important considerations. (a) *Felix qui potuit rerum cognoscere causas*: Happy is he who knows the reason why.[2] It is a pleasant thing to know why things are as they are. Aristotle begins his *Metaphysics* as follows:

---

[1] A detailed analysis of the concept of causality will be undertaken in a subsequent chapter.

[2] As translated by Professor Woodbridge.

> "All men by nature desire to know. An indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves; and above all others the sense of sight. For not only with a view to action, but even when we are not going to do anything, we prefer sight to almost everything else. The reason is that this, most of all the senses, makes us know and brings to light many differences between things."[1]

So powerful is the natural incentive to search for reasons that it was taken by both Aristotle and Plato as the original impulse which prompted men to scientific and philosophic speculation. The pure delight in finding things out makes the life of reason its own continual reward.[2]

(b) To the view that knowledge is happiness must be added the aphorism of Bacon: Knowledge is power. Knowledge of causes enables one to control effects, and inversely, ignorance of causes puts one at the mercy of effects. We may quote the following from Bacon:

---

[1] *Metaphysics,* 980a.

[2] It is not meant to imply that the origin of science is to be traced to the disinterested desire to know. The origin of philosophy and science is to be traced to much more complex and complicated beginnings.

> "We advise all mankind to think of the true ends of knowledge, and that they endeavour not after it for curiosity, contention, or the sake of despising others, nor yet for profit, reputation, power, or any such inferior consideration, but solely for the occasions and uses of life; all along conducting and perfecting it in The spirit of benevolence."[1]

The introduction of the ideas of utility and control serves as a modern supplement to the ancient aim of contemplation. To know "the reason why," therefore, is both the reward and the potency of rational living.

The following description, entitled *How Plants Know the Way Up,* is illustrative of deliberate discovery:

> "It is very fortunate for us that plants do know so certainly which way to grow in order to get out of the soil. If they did not, we humans would be very short of food. Many people would be inclined to let it go at that and think no more about it. But the scientists who study plants are (like other scientists) forever asking themselves 'why.' One of their

[1] *The Advancement of Learning,* Preface, p. 9.

'whys' is why do roots bend down in this way and why do the green shoots always bend up?

"Long series of experiments in the laboratories have shown that this is because the plants are really able to perceive gravity. . . .

"The plantlet, just as soon as it is out of the seed, knows this just as well as we do. It never mistakes 'up' for 'down' or 'down' for 'up.' Though there is still one missing link in the theory, the explanation of this lies, it is believed, in a little mechanism inside the plant, which, if man had invented it and used it in some machine, we would describe as extremely ingenious.

"The parts of the young plant that do nearly all of the growing are its very tips; the foremost half inch or so of the green shoot and about the same distance on the tips of the root. Now these growing tips, like the rest of the body of the plant, are made of 'cells,' tiny compartments or hollow granules, each one lined with a little of the living matter of the plant, the stuff that scientists call 'protoplasm.' Some of these tiny living cells, especially on the rapidly growing tips of root and shoot, have inside them some still tinier solid granules of starch, like dried peas inside an old-fashioned

baby-rattle. These starch grains, of course, are loose and they lie on the bottom of the hollow living cell that contains them. They lie, that is, on the side of the cell which is toward the earth, whichever side that may be. If you turn the cell on its side or upside down, the little starch grains move over from one side to the other, so that they are always on the downward side.

"Now these cells that contain the starch grains are trained or built somehow so that they are contented and grow normally only when the starch grains are lying on the proper side of the cell. Suppose, for instance, that the green shoot gets bent over sidewise. The starch grains in the tip cells then rest on the sides of the cells instead of their bottom. This disturbs the cell at once. All the growing cells begin immediately to grow a little crooked, in the direction that will straighten up the shoot and turn each individual cell over so that the little starch grains in it lie on the proper side of it, toward the body of the plant just as they did before.

"The starch grains behave a good deal like the lead ball inside the little tumbling dolls we used to have, the dolls that always come back

to an upright position no matter how many times one pushes them over.

"In the root the cells with starch grains in them are different, or differently trained somehow, so that the starch grains lie comfortably only on the forward or downward ends of the cells. This keeps the root always pointed downward, just as the green shoot is always pointed upward.

"Just how the loose starch grains in the cells manage to alter their growth so as to bend the root or shoot around into the proper direction is the missing link in the theory. The scientists have not yet succeeded in finding out about this part of the process." [1]

4. Deliberative Invention. In invention, the mind is more truly creative than in either selection or discovery. Walk a chalk line, we say; implying the existence of a line already drawn. But life is not always following a prescribed course already neatly marked off. Often, it seems, life is the drawing of the line. We are more designing than designed. It is a false analogy to compare induction to the fitting of a ready-made key into a lock. Our problem is more often to forge the key than

[1] E. E. Slosson, *Keeping Up With Science*, pp. 12-15.

to choose from those already made. The business-man, for instance, who makes an estimate for further contingencies is not selecting from given material. Inductive invention lies between an unregulated guess on the one hand, and a choice from existing alternatives on the other. In the former case, one makes a wild leap into the unknown and trusts to luck; in the latter he hugs the shore of the given. A manufacturer, let us say, confronted with the necessity of a revision downward of prices, has to devise a tryout price. If others in similar situations have been confronted with the same problem and have found solutions, he may select from the price revisions the one that seems to him best fitted to his case. In this event, there is mere selection from ready-made plans. Or, if he is the first to begin a revised price scale, he may make a guess and let it go at that. In neither case is the procedure that of inventive or creative thought. The procedure is genuinely creative when a carefully formulated estimate based on an analysis of present conditions and future contingencies is devised.

Much of the deliberation of practical experience is illustrative of inventiveness. To work out a plan of procedure where there is no precedent to select from, to devise a program of action, or to formulate a policy of administration are examples

in which creative imagination comes into play. In more elaborate cases of reflection, as in scientific procedure, deliberative invention takes the form of an hypothesis or a theory.

5. DELIBERATIVE RECONSTRUCTION. Accurate and an acute observation, consisting in the ability to seize the significant features of a situation; the formation on the basis of what is observed of ideas as working hypotheses; the projection of these ideas as goals of future attainment; a survey of the concrete conditions available for their realization; the testing of the ideas and the application of them to the reconstruction and perfecting of what is already going on; these traits constitute the outstanding traits of creative intelligence. In order to get a total view of the interconnection of these processes, let us consider the following example of constructive thinking which was done in connection with the pulp and paper industry:

> "Some years ago, the men who cooked our digesters, in which the wood is disintegrated, observed the natural law that if we increased the strength of the cooking acid, we would be able to decrease the cooking time. This information . . . came to the attention of the men in the acid plant, who began to study the

operation of the laws governing the absorption of sulphur dioxide gas in water.

"The acid makers, who had records of past experience before them, recalled the fact that in winter the acid was stronger than in summer. From this we reasoned that if we could create, by artificial means, the low temperature in our acid-absorbing systems that we had in winter, we should be able to maintain a uniformly strong acid all the year round. Knowing that natural laws never change, we were able to prophesy ahead what would happen if we reduced these temperatures, and, what is more important, we were able to figure out just what size refrigerating plant to install to reproduce the winter conditions.

"What we actually did because of this knowledge of natural law was to re-create the whole acid-making process, and the refrigerating plant—while it cost us nearly $60,000—was paid for by the increased productiveness of the pulp mill in a period of less than ninety days."

It should be noticed, in the first place, that this example occurs in connection with what is already going on. These men are engaged in the routine of

daily work, and the thinking which follows emerges from and has its antecedents in the customary facts and happenings of daily experience. The men in charge of the cooking and disintegration of wood *observed* the following *fact:* Increasing the strength of the acid decreases the time of the cooking. This is a fact which any observer might note. But it is the mark of an intelligent observer to see in the fact material for original thinking and to seize upon it as a fact possessing import and significance. To the careless and inattentive, facts are just facts, but to the alert and thoughtful, facts become the stimulus to the setting of problems and the material from which suggestions and ideas arise. In the present instance, the significance of the fact is turned at once into a problem.

The general problem which arose on the basis of the above observation may be stated as follows: An investigation of the operation of the laws governing the absorption of sulphur dioxid gas in water. So far nothing definite is known. The noting of a significant fact puts one on the track of an idea and experimentation is undertaken in order to ascertain whether the incipient idea is of any eventual value. Now the acid makers had "records of past experience before them." That is to say, their

information had been *classified,* and this classification is at once utilized as a means to further inquiry. An examination of the records shows that in winter the acid is stronger than in summer. Here, then, is a *new fact* (a datum), and it is this new fact, namely, the relation between the strength of the acid and temperature, that leads to the formation of a suggestion.

From the fact that the strength of the acid is greater in winter than in summer, the mind leaps to the creation of an idea. What would happen if the low temperature of winter could be uniformly maintained the year round? Why not artifically reduce the temperature and thus speed up the time necessary for disintegration?

How are we to account for the origin of this idea? And why does one mind rather than another invent it? It is exceedingly difficult, as we have already seen, to say very much governing the laws of imaginative invention. Given certain antecedents in the facts of experience, a deep interest in and concern for what one is doing, the suggestion comes as a flash of insight. Something in what is going on, it may be a fact or an accident or a chance variation, suggests a way of improvement. However, it should be noted that the suggestion comes to the man who is experimenting with the prob-

lem. Had the experiment not been undertaken it is highly probable that the idea would never have come to light. It should be remembered that the experiment was not undertaken with just that idea in mind; experimentation began merely with the view of studying a general problem. It was only as the investigation advanced that the idea emerged.

It is one thing to have a flash of insight. It is quite another thing to conserve it and to turn it to practical use. What shall be done with the idea? Shall it be allowed to evaporate and like most of our ideas be lost without being applied to the reconstruction of the facts which first suggested it?

To *reason* is to develop the implication of an idea in close relation to the concrete conditions available for its realization. It is rare that suggestions and ideas can be used in the form in which they first come to us; they must be adapted, revised, modified. This particular idea is developed through a process of reflective thinking into a working program of action. The suggestion of an artificial reduction of temperature is projected as a future end to be attained. As a projected goal, an ideal, a working hypothesis, it becomes an instrument through which things may be possibly improved. The thinking which follows consists in

the development and elaboration of this initial conception. The inductive phase of thought consists in all the operations concerned with working the idea up into a tentative plan of action. This comprises for the most part an invention of the ways and means of executing the suggestion. What would have to be done in order to adapt the suggestion to practice? One would have to construct a refrigerating plant large enough to bring about the desired results. The plans necessary for the operation of such a plant grow out of and constitute a further elaboration and development of the original idea. The result is that instead of having a mere suggestion we have a well-designed and carefully formulated plan of procedure.

But the plan must be verified. It sounds well, but will it work? Is it feasible? Will the cost of its operation be greater than the loss due to the present method? These and a great many other questions at once come up. It would be foolish to put such a plan into operation without being reasonably assured of its economic advantages. The proposal must, therefore, be tested. Here the deductive phase of thought begins. It is the essence of deduction, as we shall see later, to utilize all that one knows in order to find out what one does not know. At present what one does not know is whe-

ther the proposed plan will be economically advantageous. But one thing we do know, and that is that the laws of nature never change. That is to say, under uniform natural conditions we can be sure of getting uniform results. On the basis of the uniformity of nature, we are able to predict the future. Consequently, by the use of the knowledge of natural law and the definitely ascertained facts of elementary science, one can calculate the exact size and cost of constructing and operating the proposed refrigerating plant. He can then compare the thought-out results (logical implications) of the plan with the facts of the present system, and on the basis of this comparison judge of their relative values. If one is sure that he has taken all of the details of the plan into consideration and has made all of his calculations accurately, he may be reasonably sure of the correctness of his thinking. The method consists in thinking the plan out into its actual operating details (implication) and then laying those forecasted details alongside definitely known facts. The proof or verification is found in the agreement of the forecasted results with the known facts. When this stage is reached, a final judgment terminates the inquiry.

"What we actually did . . . was to re-create the whole acid-making process." It is in this sense

that thought is reconstructive. Some one who is sufficiently gifted to discern the significant features of what is going on, and by creative or architectonic imagination to project a vision of better things, invents the ways and means to making the ideal a reality.

In reconstructive intelligence, the life of reason finds its analogy in art. Art is the doing of something by man which nature left to herself would not do. Man was born into a world not expressly designed to satisfy his desires, yet there, if anywhere, those desires must find their satisfaction. The goal of art is to annul the discrepancy between physical nature and human nature. The method of art is the method of architectonic intelligence. Thus writes Mr. Santayana:

> "Thus if we use the word life in a eulogistic sense to designate the happy maintenance against the world of some definite interest, we may say with Aristotle that life is reason in operation. The *Life of Reason* will then be a name for the part of experience which perceives and pursues ideals. . . . Thus the Life of Reason is another name for what, in the widest sense of the word, might be called Art. Operations become arts when their purpose is

conscious and their method teachable. In perfect art the whole idea is creative and exists only to be embodied, while every part of the product is rational and gives delightful expression to the idea. . . . ."[1]

In somewhat the same vein writes Professor Dewey:

"Taste for flowers may be the initial step in building reservoirs and irrigation canals. The stimulus of desire and effort is one preliminary to the change of surroundings. Taste, appreciation, and effort always spring from some accomplished objective situation. They have objective support; they represent the liberation of something formerly accomplished so that it is useful in further operation. . . . Taste and desire represent a prior objective fact recurring in action to secure perpetuation and extension. Desire for flowers comes after actual enjoyment of flowers. But it comes before the work that makes the desert blossom, it comes before *cultivation* of plants. Every ideal is preceded by an actuality; but the ideal is more than a repetition in inner image of the actual. It projects in securer and wider

[1] *The Life of Reason*, pp. 3-6.

and fuller form some good which has been previously experienced in a precarious, accidental way."[1]

EXERCISES

1. Define analogical inference.

2. Upon what does the *value* of an inference from analogy depend? (Creighton.)

3. What are the dangers of analogical arguments?

4. What are the two uses of analogy described in the text?

5. Give two illustrations of analogies which serve the purpose of exposition.

6. Make a careful study of the analogy used by Descartes in the passage quoted on p. 233 *seq.*

7. Make a careful study of the following series of arguments from analogy used by Plato in the *Phaedo* to prove the immortality of the soul:

"Well then, he added, let us suppose that there are two sorts of existences, one seen, the other unseen.

"Let us suppose them.

"The seen is the changing, and the unseen is the unchanging?

"That may be also supposed.

"And, further, is not one part of us body, and the rest of us soul?

"To be sure.

"And to which class may we say that the body is more alike and akin?

"Clearly to the seen: no one can doubt that.

"And is the soul seen or not seen?

"Not by Man, Socrates.

---

[1] J. Dewey, *Human Nature and Conduct,* pp. 22-23.

"And by 'seen' and 'not seen' is meant by us that which is or is not visible to the eye of man?

"Yes, to the eye of man.

"And what do we say of the soul? is that seen or not seen?

"Not seen.

"Unseen then?

"Yes.

"Then the soul is more like to the unseen, and the body to the seen?

"That is most certain, Socrates.

"And were we not saying long ago that the soul when using the body as an instrument of perception, that is to say, when using the sense of sight or hearing or some other sense (for the meaning of perceiving through the body is perceiving through the senses),—were we not saying that the soul too is then dragged by the body into the region of the changeable, and wanders and is confused; the world spins round her, and she is like a drunkard when under their influence?

"Very true.

"But when returning into herself she reflects; then she passes into the realm of purity, and eternity, and immortality, and unchangeableness, which are her kindred, and with them she ever lives, when she is by herself and is not let or hindered; then she ceases from her erring ways, and being in communion with the unchanging is unchanged. And this state of the soul is called wisdom?

"That is well and truly said, Socrates, he replied.

"And to which class is the soul more nearly alike and akin, as far as may be inferred from this argument, as well as from the preceding one?

"I think, Socrates, that, in the opinion of every one who follows the argument, the soul will be infinitely more like the unchangeable—even the most stupid person will not deny that.

"And the body is more like the changing?

"Yes.

"Yet once more consider the matter in this light: When the soul and the body are united, then nature orders the soul to rule and govern, and the body to obey and serve. Now which of these two functions is akin to the divine? and which to the mortal? Does not the divine appear to you to be that which naturally orders and rules, and the mortal that which is subject and servant?

"True.

"And which does the soul resemble?

"The soul resembles the divine, and the body the mortal—there can be no doubt of that, Socrates.

"Then reflect, Cebes: is not the conclusion of the whole matter this,—that the soul is in the very likeness of the divine, and immortal, and intelligible, and uniform, and indissoluble, and unchangeable; and the body is in the very likeness of the human, and mortal, and unintelligible, and multiform, and dissoluble, and changeable. Can this, my dear Cebes, be denied?

"No indeed.

"But if this is true, then is not the body liable to speedy dissolution? and is not the soul almost or altogether indissoluble?

"Certainly."

8. As a criticism of Plato, consider the following reply made by Simmias:

"In this respect, replied Simmias: Might not a person use the same argument about harmony and the lyre—might he not say that harmony is a thing invisible, incorporeal, fair, divine, abiding in the lyre which is harmonized, but that the lyre and the strings are matter and material, composite, earthy, and akin to mortality? And when some one breaks the lyre, or cuts and rends the strings, then he who takes this view would argue as

you do, and on the same analogy, that the harmony survives and has not perished; for you cannot imagine, as he would say, that the lyre without the strings, and the broken strings themselves remain, and yet that the harmony, which is of heavenly and immortal nature and kindred, has perished—and perished too before the mortal. That harmony, he would say, certainly exists somewhere, and the wood and strings will decay before that decays. For I suspect, Socrates, that the notion of the soul which we are all of us inclined to entertain, would also be yours and that you too would conceive the body to be strung up and held together, by the elements of hot and cold, wet and dry, and the like, and that the soul is the harmony or due proportionate admixture of them. And, if this is true, the inference clearly is, that when the strings of the body are unduly loosened or overstrained through disorder or other injury, then the soul, though most divine, like other harmonies of music or of the works of art, of course perishes at once; although the material remains of the body may last for a considerable time, until they are either decayed or burnt. Now if any one maintained that the soul, being the harmony of the elements of the body, first perishes in that which is called death, how shall we answer him?"

9. Why do you think Plato described the spectacle of choice as "sad and laughable and strange"?

10. Make a thorough logical analysis of the illustration of deliberative selection. Attention should be given to the following points:

a. Non-reflective experience.
b. Origin of reflection.
c. Statement of the problem.
d. The place of impulse in reflection.
e. The place of habit in reflection.
f. Period of suspense.

g. Imaginative rehearsal.
h. Enumeration of data.
i. Enumeration of meanings, both intrinsic and extrinsic.
j. Perceptual and conceptual inferences.
k. Inductive and deductive phases.
l. Conclusion.
m. Verification.

11. Make a similar analysis of the illustration "How Plants Know the Way Up."

12. Construct and analyze an example of deliberative invention.

13. Enumerate the points in the analysis of the illustration from deliberative reconstruction.

14. Explain the analogy between reason and art. Discuss the analogy from the standpoint of what was said at the beginning of the chapter on the general subject of analogy.

CHAPTER NINE

INDUCTION

1. General Account. Induction is a forward movement of thought from facts, details (data) to a binding principle, a connected view of a situation (meaning). Since data are particular existences and meanings are general concepts, it may be said that induction is an inference from the particular to the general. For a definition we may quote Professor Dewey: *"Scientific induction means, in short, all the processes by which the observing and amassing of data are regulated with a view to facilitating the formation of explanatory conceptions and theories."*[1]

We have already seen that reasoning is not a process numerically distinct from data and meaning, but is a more advanced stage in which data and meanings, employed as materials, are incorporated in a more elaborate operation. Induction does not involve the introduction of any additional materials, but merely typifies the synthesis of all the

[1] J. Dewey, *How We Think*, p. 86.

processes involved in the analysis and classification of data and the discovery and projection of meanings. Data and meaning are, therefore, integral parts of induction. Observation, for example, is not a pre-inductive operation, void of intellectual activity, but is itself a stage in reflection and falls within the inductive movement of thought. Likewise, analysis, the enumeration of instances, the collection and tabulation of data, the operation of suggestion, the formulation of tentative meanings, and ideas, the process of hypothesis making are integral parts of inductive procedure. The processes described in the chapter on "Data" are preliminary stages of inductive inference. Analysis and classification are means of guiding reflection and rendering it effective. They are properly termed inductive when they are utilized in order to render data more significant bases of inference. The definition and formulation of a problem, for example, are undertaken in order that reflection may have a definite point of departure. While observation is not inference, it is undertaken in order that inference may proceed more intelligently.

The foregoing processes are preliminary stages in induction. The final stage consists in "the formation of explanatory conceptions and theories." In all constructive thinking there is a period of

hypothesis making, marked by the invention and projection of provisional guesses and tentative conjectures.

In so far as induction refers to the laws and conditions regulating the formation of hypotheses, it can hardly be said to be a science, so little can be said with definiteness touching the rules governing the imaginative projection of explanatory ideas. In the progress of reflection, the mind begins with facts and proceeds in the direction of some interpretative principle or explanatory concept. The procedure is not a steady and gradual rise from data to meaning. As expressed by Bacon: "Our road is not a long plain, but rises and falls, ascending to axioms [meanings, hypotheses], and descending to effects [implications]." The mind dwells on facts for a period and then suddenly, by a lofty imaginative flight, leaps forward to a guess or conjecture. It then utilizes this provisional viewpoint as a temporary means to further investigation. The "working" hypothesis is introjected as an intervening link between the original facts and the final meaning. The description of inductive procedure differs in this respect from that described by Bacon.[1] Bacon seemed to think that the

[1] The two views here attributed to Bacon are, of course, inconsistent.

imagination should be held in leash during the tedious period of fact gathering, believing that when all the facts had been assembled the explanation would come in a more or less automatic way. Accordingly, induction resolved itself into a method for collecting and amassing data, leaving little place for the creative leap of thought. He thus cautions against "the premature and forward haste of the understanding, and its jumping or flying to generalities and the principles of things." The progress of science was to be an "interpretation" and not an "anticipation" of nature. Now, as a matter of fact, it is just this hypothetical anticipation of nature that constitutes the most distinctive feature of inductive inquiry. The mind does not wait for a complete enumeration of all facts, but anticipates and then uses the anticipation as guiding principles in the further discovery of facts. One cannot, let us say, in one single heat swim from shore to shore across a very wide river. He swims first to a small island and uses it as a base for the reorganization of his energies. Ideas are just such islands in the stream of thought, temporary bases where one may pause and reorganize his intellectual resources for further advance.

Regarding the anticipatory and architectonic power of the imagination, Tyndal writes:

"With accurate experiment and observation to work upon, imagination becomes the architect of physical theory. Newton's passage from a falling apple to a falling moon was an act of the prepared imagination. . . . Out of the facts of chemistry the constructive imagination of Dalton formed the atomic theory. Davy was richly endowed with imaginative faculty, while with Faraday its exercise was incessant, preceding, accompanying, and guiding all his experiments. His strength and fertility as a discoverer are to be referred in great part to the stimulus of the imagination. Scientific men fight shy of the word because of its ultra-scientific connotations; but the fact is, that without the exercise of this power our knowledge of nature would be a mere tabulation of coexistence and sequences." [1]

On the relation between fact and hypothesis, data and meanings, the following passage from Professor Creighton is instructive:

"In speaking of hypotheses as 'guesses' or 'creations of the imagination,' their dependence upon facts must not be forgotten. It is only when the phenomena to be explained

[1] *Fragments of Science*, p. 104.

have been carefully observed that our guesses at their explanation are likely to be of value. It is well known that a considerable amount of knowledge is usually required to ask an intelligent question. And in the same way, the mind must be well stored with facts, in order to render our hypothetical explanations worthy of consideration. Indeed, observation of facts and the formation of theories go hand in hand, and naturally assist each other. We have already spoken of the lack of theory which makes us blind to facts that seem to lie directly before us. But we have perhaps not yet emphasized sufficiently the dependence of theories upon the facts of observation. The process of explanation may be described as a fitting together of the facts given by observation, with the explanatory theories which the mind originates. The theory with which we start enables us to ask questions, and leads us to scrutinize the phenomena which are to be explained; while the latter react upon the theory, and cause it to undergo constant modification. Neither the 'theory' nor the facts are to be regarded as fixed and unchanging; both are constantly changing in relation to each other as the investigation proceeds. The account of

> Darwin's discovery of the principle of 'the survival of the fittest' is a good illustration of an hypothesis constructed by a constant dependence upon the facts during every step of its progress."[1]

2. HYPOTHESIS. For a definition of hypothesis we may turn to Professor Creighton:

> "An hypothesis, taken in its most general sense, is a guess or supposition as to the existence of some fact or law which will serve to explain a fact or connection of facts already known to exist."[2]

In this definition, the word hypothesis is used in two senses: (1) the hypothesis of fact; and (2) the hypothesis of law.

The hypothesis of fact is descriptive of inductive procedure in popular reflection. Practical deliberation is concerned with particular facts and existences. If, for instance, the assumption is made that the fire was caused by a defective flue, the defective flue is an hypothesis. It is a supposition that is used to explain a particular fact. In this sense all ideas, all provisional guesses, all tentative explanations are hypotheses. The formation of

[1] *An Introductory Logic*, pp. 283-284.
[2] J. E. Creighton, *An Introductory Logic*, p. 278.

such explanatory conceptions is the very heart of inductive procedure. Every concrete instance of reflection involves the projection of trial guesses and tentative meanings. It is in this sense that induction is a forward movement from data to meaning.

The hypothesis of law typifies the use of the word in its scientific meaning. Scientific hypothesis differs from the hypothesis of popular reflection as the general differs from the particular. Science is not interested in particular instances but in general principles in terms of which great masses of facts are organized and interpreted. The difference between the "idea" that my lost hat is in the office and the "theory" of biological evolution is to be found in the complexity of the subject-matter and in the generality of the theory. Evolution as a theory is a generalized though tentative explanation of a very large group of facts, whereas a conjecture or an idea may be the proposed explanation of but a single fact or event.

The following is descriptive of the distinction:

> "We must distinguish the scientific use of the term . . . from the *popular meaning*. According to the latter, any fact used to explain another fact is called an hypothesis. Whenever something unusual strikes the attention

of the average unscientific person, he immediately puts forth the hypothesis that it must have been due to something else. If, for example, he finds a bridge out, he will explain it by the hypothesis that there has been a heavy downpour of rain in that locality, or that a heavily loaded truck or a threshing machine has broken the bridge down. Thus, in such a popular hypothesis, there is really no attempt to formulate a highly general principle of explanation to interpret a complicated mass of data. The contrast between such hypothesis of popular thought and a genuine scientific hypothesis, such as the nebular hypothesis in astronomy, is so great that the distinction between the two meanings needs no further elucidation. For even though it be admitted to be only a difference in degree, the difference is so vast that for all practical purposes it is a difference in kind."[1]

A good hypothesis must conform to at least three theoretical *requirements*. It must be simple, natural, and fruitful.

(a) *Simple*. Simplicity is the least important of the three. It seems somewhat doubful whether

[1] D. S. Robinson, *The Principles of Reasoning*, p. 308.

simplicity is the goal of science, as has so often been said; that is, whether explanation is from the complex to the simple. What is really meant, I think, is not simplicity but intelligibility. An hypothesis should be an intelligible explanation and not have itself to be explained by another hypothesis. There is another sense, however, in which simplicity seems to be a methodological principle, namely, of two hypotheses, other things being equal, choose the simpler. If, for instance, it is possible to explain the behavior of animals in terms of perceptual inference without recourse to conceptual inference, it is theoretically preferable to do so.

(b) *Natural.* For an explanation to be naturalistic the explanatory hypothesis must belong to the same order of existence as the facts which it is devised to explain, or, what is the same thing, the hypothesis must be continuous with the facts. The following quotation from Santayana illustrates the difference between science and mythology:

> "The mark of a myth is that it does not interpret a phenomenon in terms capable of being subsumed under the same category with that phenomenon itself, but fills it out instead with images that could never appear side by

side with it or complete it on its own plane of existence. Thus if meditating on the moon I conceive her other side or the aspect she would wear if I were travelling on her surface, or the position she would assume in relation to the earth if viewed from some other planet, or the structure she would disclose could she be cut in halves, my thinking, however fanciful, would be on the scientific plane and not mythical, for it would forecast possible perceptions, complementary to those I am trying to enlarge. If, on the other hand, I say the moon is the sun's sister, that she carries a silver bow, that she is a virgin and once looked lovingly on the sleeping Endymion, only the fool never knew it, my lucubration is mythical, for I do not pretend that this embroidery on the aspects which the moon actually wears in my feeling and in the interstices of my thought could ever be translated into perceptions making one system with the present image. By going closer to that disc I should not see the silver bow, nor by retreating in time should I come to the moment when the sun and moon were actually born of Latona. The elements are incongruous and do not form one existence but two, the

first sensible, the other only to be enacted dramatically, and having at best to the first the relation of an experience to its symbol. These fancies are not foretastes of possible perceptions, but are free interpretations or translations of the perceptions I have actually had.

"Mythical thinking has its roots in reality, but, like a plant, touches the ground only at one end. It stands unmoved and flowers wantonly into the air, transmuting into unexpected and richer forms the substances it sucks from the soil. It is therefore a fruit of experience, an ornament, a proof of animal vitality; but it is no *vehicle* for experience; it cannot serve the purposes of transitive thought or action. Science, on the other hand, is constituted by those fancies which, arising like myths out of perception, retain a sensuous language and point to further perceptions of the same kind; so that the suggestions drawn from one object perceived are only ideas of other objects similarly perceptible. A scientific hypothesis is one which represents something continuous with the observed facts and conceivably existent in the same medium. Science is a bridge touching experience at both ends, over which

practical thought may travel from act to act, from perception to perception."[1]

(c) *Fruitful.* It is no accident of language that hypotheses are described by the adjective 'working.' This means that they are used as guiding principles of observation and experimentation. An hypothesis whose sole use consisted in explaining given data would have some value; it would mark a stage in intellectual progress. But hypotheses are more useful when they are used as means to further advancement. This is accomplished by deducing from the hypothesis its theoretical implications. An hypothesis is a general meaning which means other meanings (implications). Deductions from an hypothesis are, therefore, truly conceptual inferences. It is in this way that hypotheses are used as instruments of prediction. If the hypothesis is true, then, we say certain facts should follow from it. These forecasted results are then either sought in observation or determined by experimentation.

It follows, therefore, that for the hypothesis to be useful, it must be such that implications can be deduced from it. Its fruitfulness consists in its resourcefulness as an instrument of prediction. An

[1] *Life of Reason,* Vol. III, pp. 128-129.

hypothesis from which nothing could be deduced, that admitted of no implications, would be barren. To say, for example, that the angels move the stars would be meaningless to one who knew nothing about the psychology of angels.

3. GUIDANCE OF INDUCTIVE PROCEDURE. The nature of the process in which the mind leaps to a tentative hypothesis is far from being open to strict scientific description. Thinking, as we know, involves a "leap" from what is given to what is suggested. The operation is not one over which we seem to be able to exercise direct control. We more or less trust to the laws of association to present us with the appropriate idea. Popular language expresses the more or less passive attitude of the mind in the reception of ideas. The idea presents itself to us, as we say; "it just occurred to me," "the thought struck me," "it gradually dawned on me," "then came a sudden flash of insight," are examples expressing what from the standpoint of ignorance of the antecedents of our thoughts may be called imaginative spontaneity. But the hypothesis of pure spontaneity would be unproductive, seeing that it is an hypothesis from which nothing could be deduced. Mechanism, the theory that our ideas are causally connected with antecedents, even though we are ignorant of what those ante-

cedents may be, is at least, inasmuch as it is assumed that there *are* antecedents, a working hypothesis. Although there is no science of induction, in the sense that the mechanism of the imaginative formation and projection of ideas is fully understood and subject to direct control, there is nevertheless a good deal that can be said regarding the indirect control of inductive discovery.

Much has been written about memory and many systems have been devised to train the memory. But it should be remembered that training of memory is *not* training one to think. The crux of productive thinking does not consist in holding in the mind a great array of facts and ideas; it consists in rendering available just that one or just those few facts and principles which bear effectively on some definite problem. Most of us possess knowledge enough to make a respectable intellectual showing; our stupidity is due to a woeful inability to use what we know in an emergency. It frequently happens that, when some one else has pointed out to us the solution of a problem which has baffled us, the solution was a part of our stock of information; but we did not think of it. It was there embedded somewhere in the total mass of what we knew; but in the crisis it failed to come forward.

The indirect guidance of inductive procedure

resolves itself into two things: regulating the method of investigation, and regulating the mind of the investigator.

(a) *Regulation of the Method of Investigation.* Much has already been said regarding the methodology of investigation. Regulating the conditions under which ideas are allowed to spring up, the avoidance of errors in observation, are examples of inductive control. We append here certain additional means of increasing the fertility of the mind in the formation of explanatory conceptions and of safeguarding procedure against error.

1. *Classification.* The technique of classification has already been described. Reference is here made to it in order to exhibit its relation to the guidance of induction. To use material implies that it must be in a *usable* form. In order to be available in an emergency, our past experience must be ordered, arranged, and systematized. Classification is to thinking what a filing system is to business. A filing system is undertaken so that when the need arises for a past fact, it can be produced with the least amount of confusion. If one's previous experience is just an unorganized mass or heap of unrelated and unassorted material, it is most likely not to be accessible or available in time of need.

Science is sometimes defined as organized or systematized knowledge. The scientist is a more effective thinker than the man of unsystematic method because he has made his facts thinkable. He knows where to turn to find what he needs. Ideas are the tools or instruments with which we handle problems. The successful thinker is the one who can put his hand on the right tool at the right time. System and classification are means to this end. Other things being equal, the man who has his information classified stands a better chance of selecting what is vital and relevant in any given circumstance.

2. *Association.* Information should be acquired in connection with the use to which it is to be put. New facts and new meanings should be associated with definite and specific needs. If this is done, then when the need arises, the idea acquired in connection with it will come as a matter of association. We usually have among our intellectual resources the necessary conceptual material for the solution of problems, but we do not think of it at the right time or in the proper connection. If knowledge is to be of value, it is in connection with the uses to which it is put. In learning new facts, therefore, deliberate effort should be made to form bonds of connection between them and the

situations to which they are going to be applied. All that one can do in any problematic situation is to trust to his mind to present him with the appropriate idea. Training the mind is in part a matter of associating ideas with situations in such a way that when the situation arises, the idea will automatically come also.

3. *Abstraction.* A problem is often solved by taking an idea which has proved effective in one context and carrying it over and applying it to another. Professor Dewey has remarked that abstraction is the main artery of intelligence. The word literally means to draw out. Abstraction, therefore, means the extraction from the total funded stock of information just that which is applicable in a given difficulty. What is new, in so-called original thinking is not, in most cases, the creation of a new idea but the application of an old idea to a new situation. The following incident, told by Alexander H. Revell, is an illustration of the carrying over of an idea from one context and applying it to another:

> "It must be thirty years ago that my telephone rang one day and I was told that Philip D. Armour wished to speak to me. . . . He told me that his firm had recently purchased

from us quite an amount of goods. He then said he believed in reciprocity; that there was a certain grade of hair they had; he understood that we used considerable of it in the lower grades of furniture. He would like very much if we would give his representative some attention. . . .

"The thought struck me: If Armour could take the time to have a personal interview with me on the telephone, I could take interest in every one who wanted to buy goods from us.

"That was the beginning of a plan I have since followed."

Since data as well as meanings are means to knowing, abstraction is applicable to the selection of relevant facts as well as to the selection of interpretative meanings. The singling out of one aspect of a situation as of special importance and using it as a basis of inference is a work of reflection. We may use the word extraction as existential, that is, as applying to data, and abstraction as conceptual, that is, as applying to meanings.

4. *Analogy.* In Chapter Eight, reference was made to the use of analogy as a fruitful means of suggesting explanatory conceptions. Under the

caption of "Analogy as a Guide in Discovery," Jevons writes:

> "There can be no doubt that discovery is most frequently accomplished by following up hints received from analogy. . . .
>
> "It would be difficult to find a more instructive instance of the way in which the mind is guided by analogy than in the description by Sir John Herschel of the course of thought by which he was led to anticipate in theory one of Faraday's greatest discoveries. Herschel noticed that a screw-like form, technically called helicoidal dissymetry, was observed in three cases, namely, in electrical helices, plagihedral quartz crystals, and the rotation of the plane of polarization of light. As he said, 'I reasoned thus: Here are three phenomena agreeing in a very strange peculiarity. Probably, this peculiarity is a connecting link, physically speaking, among them. Now, in the case of the crystals and the light, this probability has been turned into certainty by my own experiments. Therefore, induction led me to conclude that a similar connection exists and must turn up, somehow or other, between the electric current

and polarized light, and the plane of polarization would be deflected by magneto-electricity.' By this course of analogical thought, Herschel had actually been led to anticipate Faraday's great discovery of the influence of magnetic strain upon polarized light."[1]

5. *Contextual Placing.* The placing of a problem in the proper context often affords a suggestive point of departure. Once the problem is correctly placed, the context helps to arouse appropriate suggestions. For example, if one adopts as a tentative hypothesis the economic interpretation of history, he is enabled to look for antecedents which might otherwise be overlooked. Often an entirely new light is thrown on a problem when looked at from another point of view. When, for example, it is recognized that the tariff is a local and not a national issue, the whole approach to its solution is changed. How, for example, shall one approach such a problem as the relation of impulse to reflection? Taking as a point of departure Professor Dewey's statement that reflection originates in a situation characterized by the breakdown of habit and the reorganization of activity around impulse as a center, one might discuss the relation of

[1] W. S. Jevons, *The Principles of Science,* pp. 629-630.

impulse to reflection in this setting. The setting would suggest the way in which the analysis might be worked out. Or, again, in Chapter Two, an approach to reflection was made from the standpoint of two kinds of thinking. In Chapter Four the approach was made from two kinds of experience. A problem then arises as to how the two different approaches are to be reconciled. A point of departure for the reconciliation was made by referring to Mr. Santayana's view of reason as the union of impulse and ideation. When reflection is set in that context, it is seen that the distinction between two kinds of thinking is an approach from the standpoint of ideation, whereas the distinction between two kinds of experience is an approach from the standpoint of impulse and action. When the problem is stated in this form, the solution becomes automatic. The following is an illustration of the approach to the problem: Will interest rates change?

> "The beginning of all wisdom in matters pertaining to interest rates and their fluctuations is embodied in the statement that interest is a price. Since it is a price, the business man and the economist know how to attack the problem: for price is a subject which their

> experience and their training enable them to handle with some skill. They know that the forces which determine it must be grouped, for purposes of analysis, into those that affect the supply of capital and those which determine the demand. When we attempt to chart the probable cause of interest rates for the future, we must do this by forecasting the amount of capital which will come to the market as supply and the amount which will be demanded by those who are willing to pay a price and are able to furnish adequate security."

By saying that interest is a price, the problem is placed in a context which is fruitful and suggestive. It then more or less solves itself. The really difficult thing is to know what contacts and analogies and initial principles to select as basal points of reference. As in the case of children, once you give them the clue, they follow it up and find the answer for themselves. But the thinker must find his own clue.

6. *Experimentation.* We shall later consider experiment as a means of controlling inductive discovery. We may here refer to it as a means of stimulating suggestions. The natural basis of experiment lies in man's innate tendency to fool.

Having an excess of vitality, he naturally pries into things. The play instinct lies at the basis of much that is greatest in science and in art. The difference between mere fumbling and an inductive experiment is to be found in the amount of conscious care with which the process is directed and the purpose for which it is devised. To experiment is often to play with a subject. It is to utilize a natural instinct for an end beyond itself. When, for instance, an automobile suddenly stops, and one has no idea what is the matter, he gets out and pokes around, trying first one thing and then another with the hope that he may hit upon the cause of the difficulty. Inductive experiment differs from trial and error method in that it is more elaborately planned and is conducted as a means of guiding and safeguarding the formation of suggestions.

A publishing company once issued a great many copies of a book entitled *Celestial Mechanics for Lay Readers.* On the cover were elaborate drawings of mathematical curves representing the movements of the heavenly bodies. As a treatise on an interesting subject, it was expected to have a large sale. But for some reason the sales were few. The publisher exhausted all the ordinary methods of advertising and salesmanship and still

the book did not sell. It was then decided to make a radical change in the title and cover picture. The books were sent back to the printer, all the backs were ripped off, the title was changed to *A Trip to the Stars,* and a picture of the mountains on Mars replaced the mathematical drawings of the ellipses representing the orbits of the planets. In this form the book at once appealed to the imagination of the reading public.

(b) *Regulating the Mind of the Investigator.* It is one thing to regulate the conditions under which suggestions are allowed to spring up and develop. It is quite another thing to regulate one's attitude of mind in accepting or rejecting suggestions. No inconsiderable part of training in careful thinking consists in the formation of right habits of belief. Bacon has well said, "God forbid that I should give out a creation of the imagination for a pattern of the universe." All that was said touching the fallacies of observation is equally applicable in this connection. Bacon's *Idols,* for example, should be recalled and re-applied here. We may, however, add certain further considerations.

1. *Period of Suspense.* The most important single habit to form is that of suspending judgment during the period of inquiry. To accept the

first suggestion that comes is *not* to reason. There is a general impression that the first impression is the best. It *may* be the best, but it is not the best *because* it is the first. Reflection originates, as we have seen, in the breakdown of habit and in the reorganization of activity around some impulse as a pivot. But it should be remembered that impulse is only the nucleus around which reflection centers. To substitute impulse for reflection is to cut short the process of reasoning. It is not the function of reflection to eliminate impulse, for in that event all the motive power of action would be gone and we would kill the goose that laid the golden egg. Moreover, it would be to create a world in which the impractical, the visionary, the theorist, and the dreamer live. While impulse and reflection are different, neither can be a substitute for the other. Impulse without reflection is blind, reflection without impulse is impotent. Reason is born of the union of impulse with ideation. But impulse must be checked in order that reflection may intervene. Action must be temporarily halted in order that, by the aid of reflection, it may be guided and controlled.

2. *Readiness to Cope with the Unusual.* Situations rarely repeat themselves in just the form in which they first occurred. There is always an element of the novel and unique in each recurring sit-

uation. Keenness of intellect consists in the ability to detect and appreciate this marginal element of novelty. Things often do not come up just as we expect them. The slightest deviation from the average throws one off guard and leads to confusion. We look for the thing in one way and it comes up in another. We grow accustomed to solving a problem in one context and if it is presented in another we are entirely baffled. Since no two problems are exactly alike and since it is rare that we find ourselves twice in the same situation, it is well to form the habit of looking for the marginal differences that make each problem different from all others.

3. *Types of Mind.* (1) Over-credulity: The over-credulous type of mind shows a readiness to accept suggestions in the absence of any evidence in support of them. This tendency of the mind is usually designated as suggestibility. Suggestibility should be carefully distinguished from suggestion. Suggestion, as the central factor in thinking, is an indispensable process in reflection. Suggestibility means the exaggerated tendency to believe things in the absence of the necessary grounds of belief. The mind is naturally suggestible. Men are more trusting than wary. Knowing that this is a natural tendency, one must be on guard against it.

(2) Mental rigidity: At the opposite extreme

from gullibility is the rigid mind. The closed-mind type is over-cautious, wary, and suspicious, and is often impervious to suggestions. "The narrow-minded, on the other hand, can recognize and esteem no truth and no ideal, even the most universally valid, except in that special form to which they have become accustomed within a limited circle of thought and personal observation. Life is a school which corrects these habits of mind. The parochially minded man sees things persist in spite of himself in taking shapes which he considers unprecedented, but he finds the world somehow survives it, and learns at last that a system of life may be excellent and precious, but that it is rash from that to argue that it is the only proper mode of orderly existence."[1]

(3) Open-mindedness: No one word sums up this attitude. There are at least two qualities to be described, alertness and flexibility. The alert mind is the one constantly on the watch for suggestions. The alert thinker is conscious of problems, is full of questions, and is continually on the watch for some new idea that will have a bearing on his difficulties. He questions every one he meets; he uses his friends and even his enemies in

[1] Quoted from Lotze by Hibben, *Logic,* p. 162.

order to learn something from them. He is inquisitive; in conversation he is given to asking questions rather than answering them. He is seeking ideas rather than making a show of his wisdom. Alertness is characteristic of the scientific attitude of mind. Every one has observed how much great men are concerned about little things. Nothing is too insignificant to be interesting and little is too obscure to be noticed. They are ready to welcome any suggestion, no matter from what source it may come.

Alertness means quickness in responding with suggestions. Flexibility means a readiness to modify suggestions and to keep them pliable. The stiff and rigid mind, when it once takes an idea, sticks to it. It has an inveterate hostility to change. It lacks adaptability. But inductive thinking requires an attitude of adaptability, a readiness to modify an idea in the light of changing conditions. Suggestions, if they are to be worked up into a program of action, must be constantly revised, altered, added to, subtracted from, multiplied by, and even divided into parts and irrelevant portions discarded. Nothing stands still in the world; things are always changing. We sometimes work out a plan to follow and before we have put it into execution the conditions that first called it into

being have changed entirely. Events move faster than our thoughts. We have to be continually changing our ideas to meet new situations. Flexibility is an attitude difficult to maintain. The mind seems to have a native bias for finality. It likes things fixed and stable. The mind is a born conservative. The following quotation is taken from a man of practical business experience:

> "To maintain a freshness and elasticity of viewpoint and to steer clear of mental ruts worn by the performance of routine duties are two of the hardest problems any business man faces.
>
> "Men do not like to revise their notions or modify their theories. Sit in any business conference and you are almost sure to see this trait come to light. Sometime during the session you are certain to hear some one in authority voice an opinion or a decision based on out-of-date facts.
>
> "Within the last year, for instance, I have heard a manufacturer refuse to consider his sales manager's recommendation to add sales method, because he had tried it himself twelve years previous and it had failed. In that decision, he blandly ignored the fact that his

most successful competitor had been following the proposed practice with profit for more than two years.

"It is comfortable to collect a lot of impressions about your buying public and let your mind catalog each like a beetle in a museum. . . . Your mental picture of it secured by actual contact two, five, or ten years ago is just as inaccurate in its reflection of present-day interests, beliefs, and desires, as is the actual photograph taken in 1898, 1906, 1914, in reproducing today's fashions in dress."

QUESTIONS

1. Define induction.
2. Relate the processes described in the chapters on Data and Meaning to induction.
3. In what sense is induction not a science?
4. Explain Bacon's phrase "anticipations of nature."
5. Explain the two quotations from Bacon given on pages 264-65.
6. What is the relation of imagination to induction?
7. Explain Tyndal's phrase, "the prepared imagination."
8. Distinguish between scientific imagination and poetic imagination.
9. Explain the interrelation between fact and theory as described by Creighton on page 266.
10. What do you think is meant by "this" in the following statement: "This is what Royce meant, by speaking of induction as a combination of theory and practice"?

11. Define hypothesis.

12. Distinguish between the use of hypothesis in popular reflection and in science.

13. Explain the sense in which simplicity is a legitimate requirement of a good hypothesis.

14. What is meant by "Occam's razor"?

15. How do you distinguish science from mythology?

16. What is meant by saying that an hypothesis must be natural?

17. In what does the fertility of an hypothesis consist?

18. Is a barren hypothesis the same as an unverifiable hypothesis? Is the hypothesis of disembodied spirits barren or unverifiable?

19. What is the distinction between an hypothesis and a theory?

20. What is the problem in connection with the guidance of induction?

21. Review all of the material contained in previous chapters which has any bearing on the guidance of induction.

22. Explain and discuss each of the sub-topics listed under the caption "Regulation of the method of investigation."

23. Distinguish the use of analogy for the purpose of exposition from its use as suggestive of explanatory conceptions.

24. Distinguish the use of experimentation for purposes of verification from its use for purposes of discovery.

25. What types of mind are strictly unscientific?

26. What are the characteristics of open-mindedness?

ILLUSTRATIONS

1. Cite illustrations of false inductive generalizations based on "anticipations" of nature.

2. Give two illustrations each of the hypothesis of fact and the hypothesis of law.

3. Illustrate the principle of simplicity in the choice of an hypothesis.

4. Give an illustration of an unverified hypothesis, and explain why it is unverifiable. Is such an hypothesis worthy of serious consideration? If not, why not?

5. Cite three hypotheses which have led to the discovery of new facts.

6. Cite an illustration in which the classification of data is a preliminary step in the formation of an explanatory conception.

7. Illustrate the use of analogy as suggestive of an hypothesis.

8. Cite an illustration in which intellectual advance is gained by placing a problem in a fruitful context.

9. Illustrate "abstraction" as a means of inductive guidance.

10. Cite illustrations from history or from literature of the over-credulous and mentally rigid types of mind.

EXERCISES

1. What are the defects in Bacon's theory of induction?

2. What did Bacon mean by saying that the scientist proceeds by "listening to nature"? What logical point is involved in the reply that if one wishes to hear nature speak, he must ask her questions?

3. Discuss "mechanism" and "spontaneity" as hypotheses put forward to explain the appearance of inductive ideas.

4. Discuss the two following statements of Darwin: "Any fool can generalize and speculate," and "No one can be a good observer unless he is an active theorizer." (Creighton.)

5. What function does classification subserve in the following:

"Careful observation and classification of fossil remains would reveal the fact that there were gradations in the fossil series,

and that those higher in the series resembled contemporary beings more closely than those lower down. Why do animals in a particular region always appear to be related to those in the next region, so that the order of replacement is gradual? *'It was evident,'* wrote Darwin in his *Autobiography, 'that such facts as these, as well as many others, could only be explained on the supposition that species gradually become modified.'"* (Columbia Associates, *An Introduction to Reflective Thinking,* pp. 162-163.)

6. Examine critically the following use of analogy: Descartes "tried to discover the cause of thunder, and why it thundered more in summer than in winter. His theory, which is worked out in his book on Meteors, is based on his observations on avalanches, the sound of whose falling reminded him of thunder. He conjectured that the higher clouds, being surrounded by a heated atmosphere, fell upon those beneath, just as did the snow heated by the sun's rays, a theory which at the time, and before thunder was associated with electricity, seemed probable enough." (E. S. Haldane, *Life of René Descartes,* pp. 94-95.)

7. Discuss the statement: "Abstraction is the main artery of intelligence." (Dewey.)

8. Upon what does the ability to select appropriate ideas depend?

CHAPTER TEN

THE CONCEPT OF CAUSALITY

It is one of the tasks of the logician to analyze the concepts which occur most frequently in the interpretation of experience. Among such frequently occurring concepts, causality is made use of by every one in all his thinking about the sequence of events. That nothing happens without a cause is as much an assumption of every-day experience as it is of science. Spontaneity, that is, the appearance of a datum without any factual antecedent or externally determining power, is contrary to our ways of conceiving things. It is our universal experience that when we do something, something else follows and that the ensuing things are what they are because the antecedents are what they are; and conversely, that if we wish something to happen there are certain antecedent things which must first be done.

The word "cause" is a correlative term, the other term in the relation being the "effect." "Thus when one thing *B* is regarded as taking place in conse-

quence of the action of another thing *A*, then *A* is said to be the cause, and *B* the effect." A description of the conditions governing the succession of events is a problem because the cause and the effect are not usually given at the same time nor in the same way. Two factors are involved in the description, *datum* and *quaesitum*. The datum may be a given effect; it then becomes necessary to work backwards from what is observed to the cause (quaesitum). Or the datum may be a given cause; it then becomes necessary to work forward toward the effect (quaesitum). It is just because the quaesitum is not a datum that its discovery involves a problem. Causal relations, either in the form of explanation (from effect to cause) or in the form of prediction (from cause to effect) are not given in observation; they are inductive inferences.

We are concerned only with that analysis of causality which is of importance for logic. The logician is not called upon to explain how the idea of causality arises in our minds. That is a psychological and not a logical inquiry. Neither is the logician concerned with an Ultimate or First Cause, these inquiries belonging to theology and metaphysics. In the present analysis of the concept of causality, we shall be concerned primarily with the formulation of its meaning. The methods

by means of which causal relations are established and tested belong properly to deduction.

We will first attempt to formulate what we mean when we use the term. There is no one meaning of causality which can be applied with equal precision to all fields of inquiry. In popular reflection, in the sequence of historical events, in the changes and transformations of biological and social evolution, in the fixing of moral and legal responsibility, in the succession of phenomena in the domain of natural science, the term causation is used in widely different senses. Not only in separate fields of investigation, but in the interpretation of any single event, causal explanation may be approached from different points of view. A boy, let us say, throws a stone which strikes another boy and causes his death. An event as simple as this may be studied from different points of view and have adduced in its interpretation a number of causal explanations. The lawyer, the moralist, the alienist, the physicist, the physiologist, the physician, would find among the total assemblage of antecedents certain ones closely related to the effect from *his* point of view. Each would describe what from his standpoint was the cause of the death. The lawyer and the alienist would neglect the physical and physiological factors and center

their interest on the boy who threw the stone. The physicist would have no interest in the motives of the offending boy but would limit his explanation to the spheres of dynamics and kinematics, while the physiologist and the physician would be concerned with the intrasomatic changes occurring in the body of the boy who was killed. In what follows we shall attempt to define and illustrate the meaning of causality in three separate fields, those of popular reflection, historical investigation, and scientific discovery.

Practical deliberation is interested primarily in the *control* of experience. If ends are to be attained then certain preliminary steps must be taken in order to bring about the desired end. I must know what to do in order to induce, or prevent, or alter results. Control is the major intellectual aim of every day experience. From the standpoint of control, the cause is what I must do in order to bring about a result; or stated negatively, a cause is what I must not do in order to avoid a certain result. For example, if I wish the light to come on, I must press a button, and if I wish to avoid taking cold, I must not sit in a draft. Pressing a button and sitting in a draft are in popular reflection said to be causes. They are causes in the sense that they are antecedents which are singled out and used as

means to ends, or as instruments of control. They are not causes in the sense that they tell me why the light comes on or how it is that sitting in a draft causes one to take cold. They are causes from the standpoint of control, but not from the standpoint of explanation. Or perhaps it might be better said that explanation, from the standpoint of practical deliberation, consists in the detection of those antecedents in the presence or absence of which certain consequents appear or fail to appear. The discovery of these invariable antecedents tells me all I need to know for the purpose I have in mind. And when this information is gained popular reflection is not interested in pushing the analysis of causality any further.

It should also be observed that the formulation of the meaning of causality in terms of the concept of control is applicable not only to the field of popular reflection but also to much that lies within the field of practical science. Control as the aim of science was stated by Bacon in the aphorism: "Knowledge is power." This means that knowledge of causes enables one to control effects, and that ignorance of causes places one at the mercy of effects. Bacon further states the goal of science as follows: "The end of our foundation is the knowledge of causes, and secret motions of things; and

the enlarging of the bounds of human empire, to the effecting of all things possible." [1]

Let us, in the second place, comment briefly on the meaning of causality as the term is used by the historian. Herodotus, the Father of History, wrote, we are told, "in order that the things men have done might not in time be forgotten, and that the great and wonderful deeds of both Greeks and barbarians might not become unheard of,—this, and why they fought with one another." [2] The task of the historian consists in two things: telling *what* has happened and telling *why* it happened. It is, of course, in connection with the second task that the considerations pertaining to causality arise.

On the meaning of "cause" in history, we may quote at some length from Professor J. T. Shotwell:

> "Two great questions front all students of the social sciences: What happened? Why? History attempts to deal mainly with the first. It gathers the scattered traces of events and fills the archives of civilization with their records. Its science sifts the evidence and prepares the story. Its art recreates the image of

[1] *The New Atlantis,* The World's Classics, p. 265.

[2] Translated and quoted by F. J. E. Woodbridge, *The Purpose of History,* p. 5.

what has been, and 'old, forgotten, far-off things' become once more the heritage of the present. Though no magic touch can wholly restore the dead past, history satisfies in considerable part the curiosity which asks, 'What happened?' But Why? What forces have been at work to move the latent energies of nations, to set going the march of events? What makes our revolutions or our Tory reactions? Why did Rome fall, Christianity triumph, feudalism arise, the Inquisition flourish, monarchy become absolute and of divine right, Spain decline, England emerge, democracy awaken, and grow potent? Why did these things happen when or where they did? Was it the direct intervention of an overruling Providence, for whose purposes the largest battalions were always on the move? Or are the ways past finding out? Do the events reveal a meaning?

"These are not simply questions for philosophers. Children insist upon them. He is a lucky story-teller, whose Jack-the-Giant-Killer or Robin Hood is not cut through, time and again, by the unsatisfied curiosity as to *why* the beanstalk grew so high, *why* Jack wanted to climb, *why* Robin Hood lived under

a greenwood tree, etc. Many a parental Herodotus has been wrecked on just such grounds. The problem for the philosopher or scientist is just the same as that brought forward by the child. The drama of history unrolls before our eyes in more sober form; our Robin Hoods become Garibaldis, our Jack-the-Giant-Killer a Napoleon, but we still have to ask how fortune and genius so combined to place southern Italy in the hands of the one, Europe at the feet of the other. Not only is the problem the same, but we answer it in the same way. Here, at once, we have a clue to the nature of interpretation. For any one knows that you answer the child's 'Why?' by telling another story. Each story is, in short, an explanation, and each explanation a story. The schoolboy's excuse for being late is that he couldn't find his cap. He couldn't find his cap because he was playing in the barn. Each incident was a cause and each cause an incident in his biography. In like manner, most of the reasons we assign for our acts merely state an event or condition of affairs which is in itself a further page of history. . . .

"But our search for historic 'causes' is merely a search for other things of the same

kind — natural phenomena of some sort — which lie in direct and apparently inevitable connection. We interpret history by knowing more of it, bringing to bear our psychology and every other auxiliary to open up each intricate relationship between men, situations, and events. . . .

"Indeed, when we come down to it, there is little difference between 'What has happened?' and 'Why?' The 'Why?' only opens up another 'What?' Take for example a problem in present history: 'Why has the price of living gone up?' The same question might be asked another way: 'What has happened to raise prices?' The change in the form of sentence does not solve anything, for who knows what has happened? But it puts us upon a more definite track toward our solution. We test history by history. . . .

"Explanation is more knowledge of the same thing. . . .

"When you ask it 'Why?' it answers 'What?' "[1]

The view here expressed is that explanation is

[1] J. T. Shotwell, *The Interpretation of History,* American Historical Review, July, 1913, *passim.*

description. Why a thing happened is explained by describing what previously happened.

Logicians have nearly always discussed causality from the standpoint of its meaning in natural science. Science aims to explain, and scientific explanation is largely a matter of describing the conditions under which the succession of phenomena takes place. It is often said that science does not ask "why." If this were true, it would be equivalent to saying that causality is not a scientific concept at all. There is a sense in which this is true, and there is also a sense in which it is not true. Let us first state the sense in which science does not use the concept of causality.

Science does not mean by causality necessary interaction between cause and effect. That is to say, what science seeks is not some factual force residing in matter and acting upon it as an impelling agency. We may use an analogy in order to make the meaning clear. An observer, let us say, is seated in a moving picture theater and is engaged in watching the succession of images as they appear on the screen. There is nothing in one image that determines the character or appearance of the image next to follow. No analysis of one image, however minute or penetrating, can discover any-

thing in an antecedent image that exerts an influence on or interacts with or exercises a controlling power over the image next to appear. If one man is seen to strike another in the picture and the man struck is seen to fall, the image man-striking is not the "why" of the image, man-falling. If there is any causal leading up of the one to the other, or any carrying over from the one to the other, it is not anything that the observer could ever discover.

Now the scientist in investigating nature is in the same situation as the moving picture observer. The sense data which constitute the factual subject-matter of science are like the images on the screen. In their appearance and disappearance they exhibit an amazing degree of order and regularity, but the character of the connecting links, if there be any such things, remains a mystery. Before, however, denying the existence of natural bonds of connection, it may be well to note the distinction between the way things happen in nature and the way they exhibit themselves in human experience. It is not certain that our ways of conceiving things are nature's ways of doing things. It might then be thought that the mechanism of causality is skillfully concealed behind the screen of sense, much as if there were hidden wires of causal connection beneath nature's surfaces. I do not know that sci-

ence altogether denies the existence of any such cryptic causal mechanism, but it would certainly consider any attempt to discover it by means of statistical experimental methods as vain and unprofitable.

Scientific analysis reveals nothing in the way of causal interaction. If one takes a clock apart to see "why" it goes, he discovers nothing over and above the separate parts. If he were to take the spring apart in order to see why it unwinds, he would come upon nothing but molecules and their corresponding movements. If he considers the mechanism of the atom, he finds nothing beyond structural elements, their positions and their movements. Nowhere in the analysis of matter does one discover a mechanism of causality. The sense, therefore, in which science does not ask "why" is the sense in which it does not seek to find in an antecedent some hidden quality which enables it to command the effect. Interaction, in the sense of an emergent force passing from cause to effect, is not the way in which science seeks to explain the succession of phenomena.

But there is, we have said, a sense in which science does ask "why." We must now seek to formulate the meaning of causality as the term is legitimately and usefully employed in natural sci-

ence. In the first place the "why" of science is general in character. Causes in popular reflection are usually particular instances. For example, practical deliberation would say that a picture falls because the cord broke. Now science does not, except in an incidental way, seek particular causes; it does not ask why pictures fall, but why *any* unsupported body falls.

The distinction between the particular "why" and the general "why," though an important one, is not sufficient to afford the basis for a complete account of scientific causality. We must still say what science means when it uses "why" in a general sense. Science does not ask why bodies fall, it rather seeks to formulate the laws descriptive of falling bodies. When these laws have been formulated, they serve as principles of reference for causal explanation. We expound the cause when we refer to the law which describes the succession of events.

A law is a statement of the way things invariably behave. Causality is a description of the way things happen. When the succession of events takes place in a certain way, it is said to be a causal sequence. The special mode of behavior termed causal has three essential characteristics. (1) *Invariable sequence*: This means that things happen

in such a way that the same antecedent acting under similar conditions is always followed by the same consequent. Under the same circumstances A is followed by B and there is no exception to the regularity of the sequence. Stated negatively, this means that that cannot be the cause of a phenomenon in the presence of which the phenomenon fails to occur. It should be noted that all cases of causality involve invariable sequence, but not all cases of invariable sequence are cases of causality. For instance, the sequence of day and night is invariable, but not causal. Invariable sequence is a mark of causality but not the definition of it. (2) *Invariable elimination*: Things happen in such a way that the absence of an antecedent under similar conditions will always be followed by the absence of the consequent. Or stated negatively, that cannot be the cause of a phenomenon in the absence of which the phenomenon occurs. (3) *Concomitant variations*: Things happen in such a way that changes in antecedents and changes in consequents, when expressed quantitatively, are found to vary proportionately. Or stated negatively, that cannot be the cause of a phenomenon which varies when the phenomenon is constant or which is constant when the phenomenon varies.

When the sequence of events can be described in

the three ways mentioned above, it may be termed a causal sequence. A precise and generalized formulation of this description gives rise to a scientific law. The concept of causality, when generalized, leads to the conception of the uniformity of nature. This means that things are interrelated in certain very definite ways. Science is more and more describing the details of this interrelation, and is in this way extending our knowledge of the interdependence of things. This leads us to our next subject, namely, the nature of generalization.

CHAPTER ELEVEN

GENERALIZATION

1. Generalization and Explanation. In this chapter we shall deal with induction from the standpoint of logical theory. Induction is concerned with the establishment of explanatory conception; that is to say, its aim is to explain. According to Professor Creighton, "To explain is just to show that some fact or group of facts is related in an orderly way to some other fact or group with which we are acquainted." In other words, to explain is to describe what we do not know in terms of what we do know, or to describe the less known in terms of the better known. The less known is a fact or some group of facts (data), the better known is a more generalized and organized system of facts (meaning). The logical significance of the word "better" is to be found in its generality. Explanation involves the interpretation of particular facts in terms of general meanings. For instance, a blur (sense datum) is seen in the distance. What is it? It is a horse (concept,

or general meaning). The particular is subsumed under a universal. The thing which explains is more general in character than the thing explained, that is to say, explanatory concepts are more inclusive than the data to which they apply. This is more simply expressed by saying that induction is an inference from the particular to the general.

Plato says that if one were to show him the man who could detect the *one in the many,* he would follow him as if he were a god. What Plato means may be illustrated from mathematics. One may examine a number of circles. Each of the separate circles is a particular sense object. But a sufficiently gifted mathematician sees that the formula $X^2 + Y^2 = 1$ is a way of expressing the essential character of all circles. Circles are *many,* but the formula is *one.* The man to follow, according to Plato, is the one who is able to discern the principle running through all circles. Reference has elsewhere been made to his characterization of the interpenetration of the universal and the particular in every case of knowing as "the everlasting quality of reason." This means that the concept of generalization is implicated in all thinking. Generalization is the basis of intelligibility. We have already seen that without classification one would neither be able to think nor to communicate his

thoughts to others. The classes into which particular data are placed are by hypothesis more general than the data to be classified. Classification, therefore, is a device by means of which vast segments of experience can be taken in a single reference. Every intelligible proposition contains at least one universal.

When we come to consider the syllogism, the formal vehicle for expressing the results of reflection, we shall see that from two particular premises no conclusion can be drawn. This means that every inference involves at least one general proposition. Let us illustrate this *sine qua non* of inference. "I know that this is sodium by the color of the flame," or, "I infer that it is going to rain by the low barometer." In these two cases, "the color of the flame" and "the reading of the barometer" are singular terms, they are particular data. Each seems to be the sole thing we know with. But a little reflection will show that this is not the case. A single instance, a particular datum, affords no basis of inference. It is assumed that all elements which burn with a certain flame are instances of sodium (a general proposition), and that since this element burns with that flame, it is sodium. If sodium burnt with one kind of flame at one time, and with another at another time, there

being no constancy or regularity in its behavior, the mere appearance of a colored flame as a datum would afford no basis of inference. This is equivalent to saying that *both* meaning *and* data are required as instruments in knowing. Wherever, therefore, there is an inference, wherever there is thinking of the reflective type, wherever there is knowing, there is a generalization either stated or implied.

The *aim* or *goal* of scientific induction is the building up of a body of experimentally verified generalizations. Science may be defined as a body of generalized, verified, and organized beliefs. Verification and organization belong properly to deduction. Induction is concerned primarily with generalization. It is in this sense that science is frequently characterized as generalized knowledge. Although the scientist, with his emphasis on observation and experimentation, seems to be interested in particular data, his ultimate purpose is to pass beyond the facts to some general principle which may be formulated as an hypothesis or law. His preoccupation with data is merely preliminary to his real purpose. The collection and tabulation of facts, the orderly array of statistics, are never ends in themselves; they are means to the formulation of principles which describe the way the facts

invariably behave. That is to say, observation and experimentation are preliminary stages in inductive inquiry, while the ultimate goal is the discovery of laws and principles governing ultimate explanation.

2. Types of Generalization. We may divide generalizations into two main types, those which are explanatory in character and those which are merely descriptive. The latter may be termed *empirical* generalizations and the former *scientific* generalizations. Empirical generalizations, based on the enumeration of instances, rest on observations. One may know that when he presses a button the light will come on without knowing *why* it does. Such information is empirical. It is based on the observation of facts but is lacking in knowledge of the intricate order and connection between the facts. One may know how to run an automobile without any understanding of the principles involved in the construction and operation of the engine. I may know, for instance, that a certain poison will cause death without any knowledge of the physiological and chemical processes involved. Knowledge of this type is merely descriptive in character and falls short of scientific explanation. Scientific generalizations, on the other hand, go beyond the mere summation of particular instances

and express a principle, or theory, or law which is an interpretation of the instances.

This distinction is as old as Aristotle, and is well expressed in the following quotation:

> "Sense-perception of itself never gives us scientific truth, because it can only assure us that a fact is so; it cannot *explain* the fact by showing its connection with the rest of the system of facts, 'it does not give the *reason* for the fact.' Knowledge of perception is always 'immediate,' and for that very reason is never scientific. If we stood on the moon and saw the earth interposing between us and the sun, we should still not have scientific knowledge about the eclipse, because 'we would still have to ask the *reason why*.' (In fact, we should not know the reason *why* without a theory of light including the proposition that light-waves are propagated in straight lines and several others.) Similarly, Aristotle insists that Induction does not yield scientific truth. 'He who makes an induction points out something, but does not demonstrate anything.'
>
> "For instance, if we know that *each* species of animal which is without a gall is long-lived, we may make the induction that *all* animals

without gall are long-lived, but in doing so we have got no nearer to seeing *why* or *how* the absence of a gall makes for longevity."[1]

3. Empirical Generalizations. Having observed each soldier in a regiment, I may generalize and say that all the soldiers in this regiment are over six feet tall. The generalization covers a selected group of facts; it is a mere addition of what is observed in each case, and serves to describe each soldier in the group. "We are seven," "All the planets revolve around the sun," "All the students in this class are bright," are further illustrations of generalizations which are based on a complete enumeration of all the items embodied in the generalization.

The following example is cited by Professor James:

"I am sitting in a railroad-car, waiting for the train to start. It is winter, and the stove fills the car with pungent smoke. The brakeman enters, and my neighbor asks him to 'stop that stove smoking.' He replies that it will stop entirely as soon as the car begins to move. 'Why so?' asks the passenger. 'It *always* does,' replies the brakeman. It is evident from this

[1] A. E. Taylor, *Aristotle*, p. 30.

'always' that the connection between car moving and smoke stopping was a purely empirical one in the brakeman's mind, bred of habit."[1]

A second illustration of empirical knowledge is taken from Plato:

"That all those mercenary adventurers who, as we know, are called sophists by the multitude, and regarded as rivals, really teach nothing but the opinions of the majority to which expression is given when large masses are collected, and dignify them with the title of wisdom. As well might a person investigate the caprices and desires of some huge and powerful monster in his keeping, studying how it is to be approached, and how handled—at what times and under what circumstances it becomes most dangerous, or most gentle — on what occasions it is in the habit of uttering its various cries, and further, what sounds uttered by another person soothe or exasperate it—and when he has mastered all these particulars, by long-continued intercourse, as well might he call his results wisdom, systematize them into an art, and open a school, though in reality he

[1] *Psychology,* Vol. II, p. 342.

is wholly ignorant which of these humours and desires is fair, and which is foul, which good and which evil, which just and which unjust; and therefore is content to affix all these names to the fancies of the huge animal, calling what it likes good, and what it dislikes evil, without being able to render any other account of them — nay, giving the titles of 'just' and 'fair' to the things done under compulsion, because he has not discerned himself, and therefore cannot point out to others that wide distinction which really holds between the nature of the compulsory and the good. Tell me, in heaven's name, do you not think that such a person would make a strange instructor?"[1]

The logical insufficiency of induction based on complete enumeration is well expressed by Bacon: "For that form of the logicians which proceeds by simple enumeration, is a childish thing, concludes unsafely, lies open to contradictory instances, and regards only common matters."[2] Inductive generalization based on simple enumeration has three defects.

[1] *Republic*, 493.

[2] *Advancement of Learning*, Preface, p. 13.

(a) Generalizations of this type are usually trivial and unimportant. They amount to no more than mere counting and involve no more intellectual exercise than is required in the use of simple arithmetic. It is, as Bacon says, *res puerilis*. It is to be feared, it may be remarked parenthetically, that too much of what passes for scholarship is little more than a mechanical addition of the results of observation. A subject matter which is throughout accessible to observation is likely to be of no scientific interest. If by scientific truth one means complete enumeration, the kind of induction termed by Jevons *perfect* induction, then one must conclude with Bertrand Russell that "truth is unattainable except where it is unimportant."

(b) Generalizations of this type are of no explanatory value. The mere addition of numbers as such does not advance explanation. For example, I press a button and the light comes on. Why? Let me repeat the operation. Do we now know any more as to why the light comes on than we did before? Would any number of repetitions be an explanation? I might generalize and say that every time I press the button the light comes on. But the generalization affords no explanation of the cause of the phenomenon. To say that all the planets revolve around the sun may be a true gen-

eralization, but it furnishes no ground of explanation. It establishes the fact *that* it happens but does not tell *why* it happens. It is for this reason that generalizations of this kind are called *descriptive.*

(c) Finally, simple enumeration contains no principle of inference. Suppose that I say, after an examination of the individuals separately, "All the students in this class are bright." Now what are the chances that the next student I meet will be bright? The generalization expresses the results of past observation, but does not contain in it any principle which might serve as a basis for further inference. We cannot say: If student, then bright. This is equivalent to saying that no number of illustrations constitutes a definition. So long as the predicate of a general proposition expresses only an accidental or unessential attribute of the subject, the generalization is of no value in making inferences beyond the limited subject-matter previously investigated. The attribute "brightness" is merely an accidental quality of particular students observed. It does not express the essential character of "student." It is only when the predicate of a general proposition defines the subject, *i.e.,* expresses its essential nature, that the generalization has logical value as a basis of inference beyond experience. The mere enumeration of in-

stances is not enough to establish a definition.

But then, it may be asked, are not definitions themselves established through an examination of instances? Suppose that all students that had been examined were found to be bright, and no students found who were not bright, could not then brightness be taken as a definition? How many instances would be necessary to establish a necessary connection between student and brightness? Would *any* number be enough? Relying solely on enumeration of particular instances, would there not always be the possibility that the next instance would overthrow the generalization? In asking this question we are approaching the foundations of scientific induction. It may be better answered after we have examined the second type of generalization.

4. Scientific Generalizations. Scientific induction seeks not only to establish *that* certain connections hold universally, it endeavors to discover the binding principle in terms of which it is known *why* the connection obtains. When this principle is discovered it is known not only that certain things *go* together but that they *belong* together. The connection is then *necessary* as well as universal. In passing from the "that" to the "why" we pass from description to explanation. When once the principle of connection is established, it is un-

necessary then to go on counting cases and enumerating instances; the principle can be used as a basis of inference, and we know that all further cases will be expressions of the principle. It is the nature of circularity, for example, that makes the radii of a circle equal. And once this concept is grasped, it is useless to go on observing circles. A scientific generalization expresses the result of a more penetrating insight into the order and connection that obtains among phenomena. It is not content merely to describe the routine of experience; it seeks to know "the reason why." Its aim is to formulate in terms of a general principle or law the way in which things invariably behave.

Four traits characterize scientific generalizations (a) Greater certainty: Selected analysis and experimentation render scientific generalizations less liable to error. (b) Universality: *Once true, always true,* is the mark of scientific knowledge. The rising of water in a pump is an event or phenomenon which "appears in an indefinite number of similar situations, and under similar conditions it can always be repeated. A historical fact, on the contrary, cannot be repeated, because the *time* and *place* of its occurrence are essential parts of the history. Thus, it is a scientific fact that the Bahama Islands lie between parallels 20 and 27, north lati-

tude; for any competent geographer can reproduce this result for himself by computing from natural phenomena which either remain constant or are repeated at regular intervals. The historical fact, however, that one of these islands was the first land in the western world to be discovered by Columbus is a fact that in the nature of the case could happen but once."[1] (c) Organization: "The rising of water in a pump has not become a completely scientific fact until it has been connected in thought with other facts, some of which precede it while others may coexist with it. On the side of the antecedents, facts, or causes, the science of hydraulics recognizes that there are certain necessary conditions: A vacuum, for example, must be created in the tube; there must be no access to it on the part of the outer air otherwise than through the body of water which covers the open end of the tube; and this water must be exposed to the pressure of the outer air. Thus, in a measure the phenomenon of the rising of the water is explained by being connected as a consequent (that is, causally) with other phenomena more or less familiar. This explanation is then carried further by connecting the phenomenon with such more or less similar but not antecedent ones as the working of a lever of the

[1] W. F. Cooley, *The Principles of Science*, p. 8.

first kind, and even the action of a pulley. So in both directions—as to causal interdependence and as to pertinent similarities—a scientific knowledge of the suction process is an *organized* result; it consists in interlocking that process with other known phenomena, and recognizing how it is interrelated with the general system of nature. This dual relational movement is characteristic of scientific thought. It seeks always to organize its materials, to arrange phenomena in such a way as to reveal their causal articulation and their more important resemblances. Scientific knowledge is a fabric woven by thought, of which relations of causation constitute the warp and relations of similarity the woof."[1] (d) Coherent principle of inference: By means of scientific generalizations it is possible to pass beyond what has been empirically observed and make inference as to what lies beyond experience. Since, for example, rationality constitutes the essential character of man, it is possible to apply it to all men under all circumstances. We can say if man, then rational. Expressed in terms of conceptual inference, implications can be drawn from scientifically generalized propositions. It is by means of such knowledge that we can extend our inferences beyond the narrow limits of

[1] *Ibid.*, pp. 9-10.

what is given in observation. It is in this way that prediction and control are characteristic of scientific procedure.

5. METHOD OF ESTABLISHING GENERALIZATIONS. There is no problem in connection with the derivation of empirical generalizations. Generalizations of this descriptive type do not go beyond experience, that is, they contain no reference beyond what has been observed. The method by means of which they are established is that which logicians call *simple enumeration.*

But the method of establishing scientific generalizations is more difficult. It is now commonly agreed by both logicians and psychologists that all generalizations are derived from experience. But a difficulty at once appears. Experience is always in the form of particulars. That is to say, experience never affords an example of a universal. We say, "All material bodies obey the law of gravitation," but I never experience all bodies. I can examine bodies only one at a time; experience is always of a this, a that, a here, a now. As elsewhere stated, data constitute the realm of existence; meanings the realm of essence. The ideal elements employed in interpretation are not themselves on the same plane of existence as the data which they interpret.

Before attempting to state the method of arriving at scientific generalizations, we may note that generalizations are expressive of the realm of essences. Perhaps the word "structure" is the best one to use to state what is expressed in generalizations. Structure not being an observable datum is not derived from numerical additions. Structure is a statement of the order and arrangement and connection that obtains among things. The law of gravitation, for example, is a statement of the way material bodies behave. As an illustration of structure, let us say that I have a map of a city. By means of this map I can find my way around. I know the relation of one part of the city to another; I can calculate distances; I can determine directions; I can predict locations. The map enables one to organize all the separate parts into something like an intelligible whole. Or, to vary the illustration, let us say that I know the pattern of a complicated tapestry. The pattern is the key to an interpretation of the structural organization of the material entering into its composition. Until one traces the design, the tapestry is a confused and meaningless maze of sensuous material.

Now the facts of existence both in physical nature and in human experience exhibit an order and arrangement which it is the business of science to

study. It is just this pattern and structure of things that is expressed in scientific generalizations. Our problem, then, may be stated as follows: How does the scientist arrive at a knowledge of structure?

The method by means of which this is accomplished is usually termed "Induction through Analysis." It is the same in principle as the Socratic method of definition. The method is well illustrated in the following passage:

> "In contrast with the empirical method stands the scientific. Scientific method replaces the repeated conjunction or coincidence of separate facts by discovery of a single comprehensive fact, effecting this replacement by *breaking up the coarse or gross facts of observation into a number of minuter processes not directly accessible to perception.*
>
> "If a layman were asked why water rises from a cistern when an ordinary pump is worked, he would doubtless answer, 'By suction.' . . .
>
> "Now the scientist advances by assuming that what seems to observation to be a single total fact is in truth complex. He attempts, therefore, to break up the single fact of

water-rising-in-the-pipe into a number of lesser facts. His method of proceding is by *varying conditions one by one* so far as possible, and noting just what happens when a given condition is eliminated. There are two methods for varying conditions. The first is an extension of the empirical method of observation. It consists in comparing very carefully the results of a great number of observations which have occurred under accidentally *different* conditions. (Method of analysis.) The difference in the rise of the water at different heights above the sea level, and its total cessation when the distance to be lifted is, even at sea level, more than thirty-three feet, are emphasized, instead of being slurred over. The purpose is to find out what *special conditions* are present when the effect occurs and absent when it fails to occur. These special conditions are then substituted for the gross total fact, or regarded as its principle—the key to understanding it. . . .

"The method (of analysis) is passive and dependent upon external accidents. Hence the superiority of the active and experimental method. Even a small number of observations may suggest an explanation—a hypothesis or

theory. Working upon this suggestion, the scientist may then *intentionally* vary conditions and note what happens."[1]

6. THE BASIS OF GENERALIZATION. We may consider the basis of generalization from two points of view, one psychological and the other logical.

(a) *The Psychological Basis.* Water does not run down hill any more naturally than man turns observed sequences into generalizations. The small child, when injured by an older brother, says, "Yes, that is the way you *always* do." The Eskimo, starting on his hunt picks up a ham-bone and on that day kills a reindeer; the next day he does not carry a ham-bone and does not kill a reindeer. He then generalizes: Ham-bone, reindeer; no ham-bone, no reindeer.

The psychological basis of generalization is found chiefly in habit. We expect the future to be like the past. At a shooting match, for instance, I say that I believe that Smith will win the prize, giving the following as my reason: "I have been watching him, and I notice that every time he shoots, he hits the target." I then infer that the future will resemble the past.

As an approach to the problem, let us ccnsider the following passage from Bertrand Russell:

[1] Dewey, *How We Think*, pp. 150-151.

"Do *any* number of cases of a law being fulfilled in the past afford evidence that it will be fulfilled in the future? . . .

"Now in dealing with this question, we must, to begin with, make an important distinction, without which we should become involved in hopeless confusion. Experience has shown us that, hitherto, the frequent repetition of some uniform succession or coexistence has been a *cause* of our expecting the same succession or co-existence on the next occasion. Food that has a certain appearance generally has a certain taste, and it is a severe shock to our expectations when the familiar appearance is found to be associated with an unusual taste. Things which we see become associated by habit, with certain tactile sensations which we expect if we touch them. . . .

"And this kind of association is not confined to men; in animals also it is very strong. A horse which has been often driven along a certain road resists the attempt to drive him in a different direction. Domestic animals expect food when they see the person who usually feeds them. We know that all these rather crude expectations of uniformity are liable to be misleading. The man who has fed the

chicken every day throughout its life at last wrings its neck instead, showing that more refined views as to the uniformity of nature would have been useful to the chicken.

"But in spite of the misleadings of such expectations, they nevertheless exist. The mere fact that something has happened a certain number of times causes animals and men to expect that it will happen again. Thus our instincts certainly cause us to believe that the sun will rise tomorrow, but we may be in no better a position than the chicken which unexpectedly has its neck wrung. We have therefore to distinguish the fact that past uniformities *cause* expectations as to the future, from the question whether there is any reasonable ground for giving weight to such expectations after the question of their validity has been raised."[1]

The distinction here made by Mr. Russell corresponds to the one we have made between the psychological and logical basis of generalization. The logical problem is thus stated by Mr. Russell:

"The problem we have to discuss is whether there is any reason for believing in what is

[1] *The Problems of Philosophy*, pp. 96-98.

called 'the uniformity of nature.' The belief in the uniformity of nature is the belief that everything that has happened or will happen is an instance of some general law to which there are *no* exceptions. The crude expectations which we have been considering are all subject to exceptions, and therefore liable to disappoint those who entertain them. But science habitually assumes, at least as a working hypothesis, that general rules which have exceptions can be replaced by general rules which have no exceptions. . . . The business of science is to find uniformities, such as the laws of motion and the law of gravitation, to which, so far as our experience extends, there are no exceptions. . . . This brings us back to the question: Have we any reason, assuming that they have always held in the past, to suppose that they will hold in the future."[1]

(b) *The Logical Basis.* The problem we are concerned with is to determine the validity of an inference when the inference includes a statement about matters of fact which lie beyond the limits of experience.

[1] *Ibid.*, pp. 98-99.

"The question in what cases we may believe that which goes beyond our experience, is a very large and delicate one, extending to the whole range of scientific method, and requiring a considerable increase in the application of it before it can be answered with anything approaching to completeness. But one rule, lying on the threshold of the subject, of extreme simplicity and vast practical importance, may here be touched upon and shortly laid down.

"A little reflection will show us that every belief, even the simplest and most fundamental, goes beyond experience when regarded as a guide to our actions. A burnt child dreads the fire, because it believes that the fire will burn it to-day just as it did yesterday; but this belief goes beyond experience, and assumes that unknown fire of to-day is like the known fire of yesterday. Even the belief that the child was burnt yesterday goes beyond *present* experience, which contains only the memory of a burning, and not the burning itself; it assumes, therefore, that this memory is trustworthy, although we know that memory may often be mistaken. . . .

"And an answer, of utter simplicity and uni-

versality, is suggested by the example we have taken: a burnt child dreads the fire. We may go beyond experience by assuming that what we do not know is like what we do know; or, in other words, we may add to our experience on the assumption of a uniformity in nature."[1]

The uniformity of nature, therefore, is taken as the logical basis of induction. The assumption that nature is throughout a uniform system means that the unexplored regions of nature are just like the explored regions, and, on the basis of this assumption, we are able to infer from what has been experienced to what lies beyond experience.

The uniformity of nature is sometimes expressed as the principle of identity. It is thus formulated by Jevons:

"The fundamental action of our reasoning faculties consists in inferring or carrying to a new instance of a phenomenon whatever we have previously known of its like, analogue, equivalent, or equal. Sameness or identity presents itself in all degrees, and is known under various names; but the great rule or inference embraces all degrees and affirms that *so far as there exists sameness, identity, or like-*

[1] W. K. Clifford, *The Ethics of Belief.*

ness, what is true of one thing will be true of the other."[1]

In further clarifying the principle of identity the following passage from Professor Creighton is especially instructive:

"The question of how this identity of nature, which connects things, is to be conceived, is a very fundamental one, both in science and philosophy. We have already seen that, to discover a genuine identity, it is necessary to penetrate beyond striking resemblances and superficial sense qualities to some deeper-lying nature. Moreover, the universal nature of a thing cannot be discovered in the form of some essence or substance that remains permanent and unchanging. It must rather be conceived dynamically, as a mode of activity, or rather as a system of activities in which all the parts are involved, and through which they are correlated. And, furthermore, the activity of a thing, which constitutes its nature, carries it, so to speak, beyond its own boundaries. It acts upon other things; and is in turn influenced by them. Its so-called properties are statements of its relation to other things. It

[1] S. Jevons, *The Principles of Science*, p. 9.

cannot, therefore, be conceived as an isolated, unchanging essence, but must be defined through the constancy or behavior shown in its changing relations to its environments. For example, the universal nature of man is not found in some unchanging substance, either material or spiritual, that inheres in the different human individuals. It consists rather in the system of functions, physical and mental, through which he expresses his relation to the world of person and things. Nor, in the case of man, are the activities which constitute his nature modes of reacting with unvaried uniformity, but functions of adjustment and organization which develop in the light of the work they are called upon to perform." [1]

Finally, it should be remembered that the uniformity of nature is an assumption, and is not itself an inductive generalization. It might be supposed that since uniformities are observed here, and again there, we can generalize and infer that they obtain everywhere. But a little reflection will show that the principle of uniformity has been assumed in the generalization, the assumption being that the uniformities are uniform.

[1] J. E. Creighton, *An Introductory Logic*, p. 204.

7. Fallacies of Generalization. There are three fallacies which are intimately connected with generalization and against which one must be constantly on guard.

(a) *Post hoc ergo propter hoc.* This phrase may be translated: after this therefore on account of this. Mere temporal sequence is mistaken for causal connection. For example, a change in political administration is followed by a fall in prices; it is then inferred that the fall in prices was due to the political change. The fallacy is illustrated in Rostand's celebrated play, "Chanticleer." It had been the life habit of the cock to crow every morning at sunrise. The cock drew the inference that the rising of the sun was caused by his crowing. But one morning Chanticleer forgot to crow. Later, upon observing the rising sun and realizing the futility of his vigilance, he died from wounded pride.

(b) *Converse Fallacy of Accident.* This fallacy corresponds to what is more usually termed a hasty generalization. The tendency to generalize is deeply ingrained in our natures. Bacon's attack on "anticipations of nature" was directed against this natural impulse. "The understanding," he says, "must not therefore be supplied with wings, but rather hung with weights, to keep it from

leaping and flying."[1] Because a thing is observed to be true under a given set of conditions we are likely to infer that it holds true under all conditions. The fallacy consists in the failure to note that the truth of the particular instance was due to its accidental character and contained, therefore, no basis for generalization. We would be committing this fallacy, if, for instance, we should say that because Edison sleeps only four hours a day and accomplishes a great amount of work, four hours is an adequate amount of sleep for anybody. The two following illustrations are taken from Professor A. L. Jones:

> "The major received a D.S.O. for attacking the enemy and appropriating their supplies; therefore it is praiseworthy to steal."
>
> "This reformer was working for selfish ends all the time; no more reformers for me."

(c) *Composition.* The Converse Fallacy of Accident arises in connection with the relation between *some* and *any*. The fallacy of Composition arises in connection with the relation of *part* and *whole*. The distinction between the two types of fallacy is based on the distinction between the distributive and collective use of terms. Terms are

[1] *Novum Organum,* Aphorism CIV.

used distributively when they refer to any one of the many objects included in a class. Thus "chair" or "table" refers to any chair or any table. Collective terms refer to many in one. They are illustrated by such terms as "congregation," "grove," "jury," "army," *etc.* Collective terms are, therefore, wholes which are made up of parts.

The fallacy of composition is committed when we argue from what is true of the parts to the truth of the whole. Because each member of a jury is an honest man, we could not logically infer that the jury as a whole would return an honest decision. Again, each living thing grows old, but the world of living things never grows old. The important field of "mob psychology" seems to show that men's ways of thinking when members of a crowd are quite different than their modes of thinking as individuals. The larger social problems in connection with "collectivism" and "unionism" involve important considerations of the whole and part relation.

QUESTIONS

1. What is the relation of generalization to explanation?
2. What do you understand by the logical problem of "the one and the many"?
3. Discuss the statement: "Generalization is the basis of intelligibility."

4. Is it ever possible to have knowledge in terms of data only? If not, why not?

5. Discuss generalization as the goal of science. Is there any generalized knowledge which is not scientific?

6. Define science.

7. What is the distinction between empirical knowledge and scientific knowledge? Discuss fully.

8. Why, according to Aristotle, is sense-perception incapable of yielding scientific truth?

9. Explain Aristotle's statement: "He who makes an induction points out something, but does not demonstrate any thing."

10. What is here meant by "induction" and "demonstration"?

11. If "induction" is not "demonstration," what logical processes would you say are concerned with demonstration?

12. Is Aristotle's distinction between induction and demonstration equivalent to that between empirical and scientific knowledge?

13. Interpret the illustration cited from Plato on page 318.

14. What are the logical defects of empirical knowledge? Discuss fully.

15. Discuss each of the traits in respect to which scientific knowledge is superior to empirical knowledge.

16. What is the distinction between a scientific fact and an historical fact? Does this mean that history is not science? What is the nature of historical generalizations? What is historical explanation?

17. By what method are empirical generalizations established?

18. Explain the statement: Scientific generalizations are expressive of "structure." Give as many different statements of structure as you can. Is structure the same thing as "law"?

19. What do you understand by "induction through analysis"?

20. Make a thorough logical analysis of Dewey's example of "induction through analysis."

21. Would you include experimentation as a part of the general method of "induction through analysis"?

22. Explain the distinction between the psychological and logical basis of generalization.

23. Relate this distinction to the following made by Russell: "We have therefore to distinguish the fact that past uniformities *cause* expectations as to the future, from the question whether there is any reasonable ground for giving weight to such expectations after the question of their validity has been raised."

24. What is the connection between the logical basis of generalization and the hypothesis of the 'uniformity of nature'?

25. How is the principle of 'uniformity' formulated by Clifford?

26. How is "the great rule of inference" expressed by Jevons?

27. Relate Jevon's statement to that of Russell and Clifford.

28. How does Creighton interpret the "principle of identity"?

29. Explain each of the three fallacies of generalization.

30. What is the distinction between "distributive" and "collective" terms?

31. Distinguish between the distributive and collective uses of the words "all" and "many."

ILLUSTRATIONS

1. Illustrate the problem of the "one and the many."

2. Illustrate the statement: "Generalization is implicated in all thinking."

3. Give three illustrations of empirical generalizations.

4. Illustrate each of the logical defects of empirical generalizations.

5. Give three illustrations of scientific generalizations, and explain why they are scientific.

6. Illustrate each of the traits in respect to which scientific generalizations are logically superior to empirical generalizations.

7. Construct an example to illustrate "induction through analysis."

8. Illustrate the distinction made by Russell on page 332.

9. Illustrate Creighton's interpretation of "the principle of identity."

10. Illustrate each of the fallacies of generalization.

EXERCISES

1. Make a thorough logical analysis of the following passage, which is probably Plato's most famous figure of speech, the allegory of the cave:

> "Now then, I proceeded to say, go on to compare our natural conditions, so far as education and ignorance are concerned, to a state of things like the following. Imagine a number of men living in an underground cavernous chamber, with an entrance open to the light, extending along the entire length of the cavern, in which they have been confined, from their childhood, with their legs and necks so shackled, that they are obliged to sit still and look straight forward, because their chains render it impossible for them to turn their heads round; and imagine a bright fire burning some way off, above and behind them, and an elevated roadway passing between the fire and the prisoners, with a low wall built along it, like the screens which conjurors put up in front of their audience, and above which they exhibit their wonders.

"I have it, he replied.

"Also figure to yourself a number of persons walking behind this wall, and carrying with them statues of men, and images of other animals, wrought in wood and stone and all kinds of materials, together with various other articles, which overtop the wall; and, as you might expect, let some of the passers-by be talking, and others silent.

"You are describing a strange scene, and strange prisoners.

"They resemble us, I replied. For let me ask you, in the first place, whether persons so confined could have seen anything of themselves or of each other, beyond the shadows thrown by the fire upon the part of the cavern facing them?

"Certainly not, if you suppose them to have been compelled all their lifetime to keep their heads unmoved.

"And is not their knowledge of the things carried past them equally limited?

"Unquestionably it is.

"And if they were able to converse with one another, do you not think that they would be in the habit of giving names to the objects which they saw before them?

"Doubtless they would.

"Again: if their prison-house returned an echo from the part facing them, whenever one of the passers-by opened his lips, to what, let me ask you, could they refer the voice, if not to the shadow which was passing?

"Unquestionably they would refer it to that.

"Then surely such persons would hold the shadows of those manufactured articles to be the only realities.

"Without a doubt they would."[1]

2. Relate the following passage from Bacon to his description of the inadequacy of induction through enumeration:

---

[1] *Republic*, p. 493.

"The understanding, when any proposition has been laid down, forces everything else to add fresh support and confirmation; although most cogent and abundant instances may exist to the contrary, yet either does not observe or despises them or gets rid of and rejects them by some distinction, with violent and injurious prejudice, rather than sacrifice the authority of its first conclusion. It was well answered by him who was shown in a temple the votive tablets suspended by such as had escaped the peril of shipwreck, and was pressed as to whether he would then recognize the power of the gods, by an inquiry. But where are the portraits of those who have perished in spite of their vows? All superstition is much the same, whether it be that of astrology, dreams, omens, retributive judgment, or the like, in all of which the deluded believers observe events which are fulfilled, but neglect and pass over their failure, though it be much more common." [1]

3. Make a careful study of the following passage from Santayana, and relate it to the status of generalization in explanation:

"Knowledge is not eating, and we cannot expect to devour and possess *what we mean.* Knowledge is recognition of something absent; it is a salutation, not an embrace. It is an advance on sensation precisely because it is representative. The terms or goals of thought have for their function to subtend long tracts of sensuous experience, to be ideal links between fact and fact, invisible wires behind the scenes, threads along which inference may run in making phenomena intelligible and controllable. An ideal that should become an image would cease to be an ideal; a principle that is to remain a principle can never become a fact. A God that you could see with the eyes of

[1] *Novum Organum,* Aphorism XLVI

the body, a heaven you might climb into by a ladder Planted at Bethel, would be parts of this created and interpretable world, not terms in its interpretation nor objects in a spiritual sphere. Now external objects are thought to be principles and sources of experience; they are accordingly conceived realities on an ideal plane. We may look for all the evidence we choose before we declare our inference to be warranted; but we must not ask for something more than evidence, nor expect to know realities without inferring them anew. They are revealed only to understanding. We cannot cease to think and still continue to know."[1]

The foregoing passage should be studied in the light of the following table of distinctions:

Existence	*Essence*
Data	Meaning
Particulars	Universals
Many	One
Facts	Generalization
Immediate	Representation
Real	Ideal
Scattered items	Binding principle
Perception	Understanding
Illustration	Definition
Embrace	Salutation
Matter	Form

4. Make a logical analysis of the following description of 'induction by scientific analysis':

"The scientist does not pass from the facts to the law. *He finds the law, or, better, the systematic connection in the instances.* This he is able to do by subjecting a variety

[1] *Life of Reason,* Vol. I, p. 77.

of instances to careful analysis or even to experimentation, and by comparing and studying the results *until the underlying system, of which the instances and their elements are all fragments, is finally brought to light and formulated as a law.* This is what Royce meant, by speaking of induction as a combination of theory and experience. The facts are experienced, and when they are analyzed their elements are experienced—if not with the naked eye, then by the help of high-powered microscopes and other instruments of observation. But mere experience, mere enumeration, mere observation of the data resulting from analysis and experimentation is not enough. The mind must see as well as the eye. The underlying system of connections, in which each separate fact and datum lives and moves must be brought to light by the intellectual activity of the investigator. This is theory. When theorizing brings the system to light the law is discovered."[1]

5. Relate the following to the *part* and *whole* relation: "We must die in order that the world may remain eternally young." (Marcus Aurelius.)

6. How do you reconcile the two following sentences: "Everything changes" (Heracleitus) and "There is nothing new under the sun" (Solomon)?

7. What fallacies are committed in the following:

(a) "A monopoly of the sugar refining business is beneficial to the sugar-refiners; and of the corn trade to the corn growers; and of silk-manufacture to the silk weavers; and of labor to the laborers. Now all these classes of men make up the whole community. Therefore a system of restrictions upon competition is beneficial to the community."

(b) "Certain men have risen to positions of prominence who

---

[1] D. S. Robinson, *The Principles of Reasoning*, 211-213.

never went to college. Therefore a college education is unnecessary to equip a man for his life work."

(c) "Washington cautioned his contemporaries against entangling alliances; therefore, if he could advise us to-day, he would say, Keep out of the League of Nations," (Dotterer.)

(d) "Saboza, paramount chief of Swaziland, the African potentate who visited England last year, occupied a palatial residence in the British capitol, and paid his respects to King George at Buckingham Palace, returned to his homeland only to find his coal-black tribesmen would not approve their big chief's bills for travel and entertainment. A nine months' drought occurred in Swaziland and the Swasis thought Saboza had caused it. In fear and terror they came through with the money for the chief's debts . . . And then it rained. Saboza had relented. Now the chief is planning another trip." [1]

---

[1] From *The New York Times,* Feb. 27, 1924.

CHAPTER TWELVE

DEDUCTION

Induction deals with the formulation of explanatory conceptions. It is a forward movement of thought and has as its aim the envisagement of working hypotheses. Deduction deals with the verification of meanings. It is a backward movement of thought and has as its aim the establishment of proof. The two processes go together. We do not first formulate a fully matured hypothesis and then test it. But the finished product emerges through a continuous and expanding process of reasoning consisting in tentative trials and verificatory checks. The two phases of reasoning are separated for purposes of analysis and description.

1. General Description of Deduction. In order to comprehend the deductive process let us begin with an illustration. I go into my office, and to my amazement find everything in confusion. The windows are open, papers are scattered over the floor, chairs are overturned, the drawers of

my desk are open, *etc.* It is necessary to form some hypothesis as a means of explaining the disorder. The papers on the floor attract my attention, and my first impression is that a gust of wind is responsible for the damage. Before taking time to consider this impression, I think of the janitor, who I noticed was intoxicated when I left the office an hour earlier. Remembering also that I had left a Liberty Bond in my office desk, almost instantaneously my mind leaps to the idea of a burglar. Here, then, are three possible explanations. Each, in so far as it is a tentative solution of the problem, is an idea. Each idea is what a superficial and initial observation of the data indicates. The inductive side of thinking, in this case, is simple. The ideas come to me as almost integral parts of the situation.

I do not at once accept or reject any one of the suggestions. That is, I do not at once call in the janitor or sound the burglar alarm. I wish to have some evidence before I act. When I collect myself from the initial shock, I begin to consider each of these ideas. Thinking is almost wholly a matter of testing and proof. What reasons are there for thinking (proving) that the wind, or the janitor, or a burglar was the cause?

What about the wind hypothesis? I cannot directly prove that the wind is the cause, because the

event is now over and I cannot call the wind back and question it. I must resort to some indirect method of proving or disproving the hypothesis. Now from my previous experience with wind, I know what it does and what it does not do. I begin to examine the state of the disordered office from the standpoint of what I know about winds. If the wind did the damage, there are certain things I would naturally expect, and certain things I would naturally not expect (conceptual inferences). I would not expect the wind to overturn a heavy chair in the back of the room and leave the cover of my typewriter, which was lying on a table near the window, unmoved. The moment I apply the logical *implications* of the wind idea to the facts in the case, I find no coherence between things as they are and things as they would be *if* the wind hypothesis were the true one.

Thinking of the Liberty Bond, my mind next turns to the idea of burglary. Could it have been that my office had been robbed? The procedure in this case is just what it was in investigating the wind hypothesis. From my previous experience I know something about the concept of burglary. I test the burglary hypothesis by applying what I know about burglars in general (implications from the concept of burglary) to the facts (data) of this

particular case. I go from the concept of burglary back to the disordered conditions of the room (backward movement from meaning to data) and re-examine them from that point of view.

It is unnecessary to ply this illustration further. One thing stands out clearly. Deduction means using what one knows (conceptual information about wind, burglars, intoxicated janitors) to find out what one does not know (the cause of the disordered room). It means the testing of an hypothesis by bringing its logical implications (arrived at through conceptual inference) into line with the facts in the case. It is a process of checking back from the suggested meaning to the data which first suggested it. It means bringing previous experience (in its generalized form) to bear on present distress. One who knew nothing in general about winds, burglars, and intoxicated janitors could never solve this particular problem.

The checking back process (deduction) is of the utmost importance. Problems arise, we formulate a theory, and before testing it, proceed to act on it. The consequences are often disastrous. If we had only thought deductively, we might have seen at a glance that the theory would not work. It is here that so many fail. They have schemes, projects, and plans, but they are not practical. Such men we

call visionary. They are lacking in the power to do deductive thinking. Their visions are not germane to the problem and have not been thought through with reference to the demands of a concrete situation. Deduction means thinking a plan out into details, tracing consequences and anticipating results. It is seeing an idea through.

In going back to the facts (movement from meaning to data) you do not go back to the facts you started with. If you went back to the original data, you would have just what you started with, namely, the same data. This would be a circular process in which there would be no intellectual advance. What you do is to go back under the guidance of the hypothesis in search of additional facts. The hypothesis is a means of supplementing and adding to the original facts. It serves to bring out more details. It makes the investigation more fruitful; it widens the scope of observation and gives one a larger grip on the problem. It is a first principle of observation that we see what we are looking for. Just to look with no purpose in view, to see only what happens to catch our attention, is usually not to see very much. But armed with the regulating power of ideas, we are able to look the situation over with a purpose in mind. The result is that the problem is more definitely located, new

facts are brought to light and the entire thought process is facilitated. The deductive process may, therefore, lead to a further elaboration and modification of the hypothesis. So back and forth we go, from facts to idea, back to new facts, forward to a revised idea, and so on until the situation is entirely cleared up. Observation, induction, deduction are integrated into one continuous and interrelated process of inquiry.

We can now state more clearly the instrumental rôle of ideas. They function as instruments of control, prediction, and criticism. As instruments of control, ideas are used to guide observation and to direct experimentation. As instruments of prediction, they enable one to forecast, to anticipate, to deal with the novel. As instruments of criticism, they afford standards of comparison between what is and what ought to be.

2. VERIFICATION OF HYPOTHESES. Two steps are involved in the verification of hypotheses. Together they constitute a universal method of procedure which can be employed in all deductive thinking. Both steps have been constantly referred to in what has preceded; they are here definitely formulated for special study. The technique of verification involves, first, the deduction of the theoretical implications of the hypothesis; that is, the

tracing out in imagination of the necessary consequences of the hypothesis. This step involves conceptual inference; it is the logical deduction of what ought to follow on the assumption that the hypothesis is true. Secondly, a comparison is made between the logically deduced implications of the hypothesis with the facts as they are given in observation, or as they are determined by experimentation. The verification, or proof, or truth of the hypothesis consists in the harmony or agreement between theory and fact.

For example, let us say that I am about to get off of a train as it comes into the station. I begin to gather up my possessions, and as I do so, I wonder whether I am leaving anything. I ask myself: What ought I to have? Well, I say, running over them in my mind, I ought to have an umbrella, a suit-case, an overcoat, a tennis racket, and a hat box. However simple the procedure may be, what I have done is to set up certain theoretical requirements, and the doing of this constitutes the first step in answering my first question. In the second place, I turn to observation. I look to see if the articles are all there. I *ought* to have five items. Here they *are*. And so I am *sure* that I have everything. The basis of the surety is found in the agreement between what ought to be and what is. The facts

given in observation comply with the theoretical demands placed upon them by thought. In this correspondence or agreement between actual facts and logical implications deduced from an hypothesis is to be found the basis of proof.

Let us take an illustration in order to show the process of verification and the interlocking of induction and deduction in practical experience. The problem is one relating to rates of interest, or "What should money cost?"

> "Money is merely a commodity and it is not so much what you can afford to pay for its use as what you can pay. What you expect to make out of the money gives an easy guide as to what you can afford to pay.
>
> "Considered on this basis we can arrive at an idea of how much we can afford to pay for money. A rule might be phrased somewhat in this fashion: The amount that can be paid is the comparison between the annual charges put upon business by the new money and the additional income which the new money will provide by furnishing additional facilities.
>
> "Working out this rule not only sends us to the examination of our present statement of conditions and statement of operations—more particularly statement of operations—but also

> compels us to look ahead to see what business we may reasonably expect to do in the future. Then we find that instead of working forward from a plant of a certain capacity to a market we must work back from the market to the plant.
>
> "It is the sales that determine the capacity and the amount of money required, and it is my view that no financing can be intelligent unless first a definite sales plan is formulated and carried through. . . . It is the sales that determine the size of the plant. That is the plan we have carried out with our company."

On the basis of specifically ascertained facts concerning the nature and character of the problem, it is possible to "arrive at an idea" as to a possible solution. That is to say, we can now formulate a tentative estimate of what we can afford to pay for the desired money. The "idea" is worked up into an inductive generalization which takes the form of a general principle and is phrased as follows: "The amount that can be paid is the comparison, *etc.*" The rule, involving a general principle of procedure, is summarized in the closing paragraph in a simpler way: "It is the sales that determine the size of the plant."

The trend of thought has been forward from the problem, "What should money cost," to a general principle or rule, or what may in a logical sense be termed a "working hypothesis." The rule that it is the sales that determine the size of the plant is a guiding principle of action. What is going to be done from now on is "determined" (*i.e.,* deduced) from this principle which is set up as an intellectual tool to work with. Future action is to be regulated by the demands of the rule. It is the "rule" that "sends" one to the examination of the facts and that "compels" one to make predictions as to the course of future action.

Beginning with the words, "Working out this rule," the movement of thought takes an entirely different direction. Thought executes an about face; it looks back to the problem and reviews it from the standpoint of an hypothesis. In the first place, the application or working out of the rule "sends us to an examination of our present statement of conditions and statement of operations." One of the essential functions of deduction is to guide observation; to aid in scrutinizing and analyzing the initial facts with a view to a more precise formulation and definition of the difficulty. Deduction, by supplying a controlling purpose, affords a point of view from which to

survey a situation. In the second place, the working out of the hypothesis "compels us to look ahead." In applying the hypothesis as an instrument of prediction, "we find that instead of working forward from a plant of a certain capacity to a market we must work back from the market to the plant."

Let us now note the two steps involved in the verification of the plan. The first thing to do in putting an hypothesis to work is to use it as an instrument of prediction. This is equivalent to saying that it is the function of intelligence to forecast the future in order to give it direction and control. In carrying out this process, reasoning falls into the following form: if the hypothesis is true, certain consequences ought to follow from it. The forecasting of these consequences is the same thing as the deduction of the logical implications of the hypothesis. In the illustration under examination, "the working out of the rule . . . compels us to look ahead to see what business we may reasonably expect to do in the future." The operation of an hypothesis implies as an inevitable consequence (implication) the occurrence of certain results. Herein lies its working value; and, as we have seen, hypotheses are fruitful and productive just to the extent that predictions can be made from

them. It is one thing to build a plant of a given size and then sell as much as the plant can produce. It is quite another thing to estimate how much one can sell and then construct a plant to conform to the volume of sales. The former procedure involves no creative work of intelligence; it is to let circumstances determine the course of affairs. The second procedure is to substitute ideas as means and agencies of direction and control. The calculation and estimation of how much one can sell is a matter of forecasting and prediction. It corresponds to the deduction of implications.

The second step in verification consists in a comparison of implications with the facts of the case. Having deduced (by conceptual inference) the possible volume of sales, we now compare what we *could* do with what we *are* doing. In order to bring the capacity of production up to the full capacity of sales, the present plant must be enlarged, revised, reconstructed. The size of the plant and the amount of money required for its reconstruction are deductions from the statement that it is the sales that determine the size of the plant. The reorganization is made on the basis of the estimate of the future volume of sales. The thought process consists in a review of the present from the standpoint of an ideal future. Then you change what is now

being done in such a way that the idealized future (*i.e.,* the deduced implications) shall become a reality. You compare the amount of money necessary to enlarge and reconstruct the plant with the amount of money you expect to gain from the increased volume of sales. It is this comparison that constitutes the final testing, or proof, or verification of the hypothesis. The reconstruction of actual conditions in order to make them conform to theoretical requirements is of course analogous to experimentation in more strictly scientific procedure. The difference between experiment and reorganization is analogous to the distinction between deliberative discovery on the one hand and deliberative invention and reconstruction on the other. In the one case experiment is used in the interest of discovery; in the other reorganization is undertaken in the interest of practical control and progress.

Thus thought makes its rounds. From the facts that set the initial problem, it moves forward in the direction of an explanatory hypothesis; from the hypothesis to the results and consequences which can be deduced from it; from the theoretical implications of the hypothesis back to the original data in search of additional confirmatory facts. Thought expands and progresses by alternately

looking ahead and looking back. The passage from facts to ideas and from ideas to facts is continuous and the two phases of thought are complementary to each other.

The following description given by Minto distinguishes, in slightly different terminology, the same stages in the continuous expansion of thought:

> "Given a perplexity as to the cause of any phenomenon, what is our natural first step? We may describe it as searching for a clue; we look carefully at the circumstances with a view to finding some means of assimilating what perplexes us to what is already within our knowledge. Our next step is to make a guess, or conjecture, or, in scientific language, a hypothesis. We exercise our Reason or *Nous,* or Imagination, or whatever we choose to call the faculty, and try to conceive some cause that strikes us as sufficient to account for the phenomenon. If it is not at once manifest that this cause has really operated, our third step is to consider what appearances ought to present themselves if it did operate. We then return to the facts in question, and observe whether those appearances do present themselves. If they do, and if there is no other

way of accounting for the effect in all its circumstances, we conclude that our guess is correct, that our hypothesis is proved, that we have reached a satisfactory explanation.

"These four steps or stages may be distinguished in most protracted inquiries into cause. They correspond to the four stages of what Mr. Jevons calls the Inductive Method *par excellence,* Preliminary Observation, Hypothesis, Deduction, and Verification. . . . We might call the method the Newtonian method, for all four stages are marked in the prolonged process by which he made good his theory of Gravitation."[1]

3. EXPERIMENTAL VERIFICATION. The second step in the process of proof consists in comparing the implications of an hypothesis with the facts in the case. This step takes, as we have seen, two forms, namely, observation and experimentation. The experimental variation of conditions is of sufficient importance to merit separate treatment. On the difference between observation and experiment we may quote Jevons:

"It is usual to say that the two sources of experience are Observation and Experiment.

---

[1] W. Minto, *Logic,* pp. 334-335.

When we merely note and record the phenomena which occur around us in the ordinary course of nature we are said *to observe.* When we change the course of nature by the intervention of our muscular powers, and thus produce unusual combinations and conditions of phenomena, we are said *to experiment.* Herschel justly remarked that we might properly call these two modes of experience *passive and active observation.* In both cases we must certainly employ our senses to observe, and an experiment differs from a mere observation in the fact that we more or less influence the character of the events which we observe. Experiment is thus observation *plus* alteration of conditions.

"It may readily be seen that we pass upwards by insensible gradations from pure observation to determinate experiment. When the earliest astronomers simply noticed the ordinary motions of the sun, moon, and plants upon the face of the starry heavens, they were pure observers. But astronomers now select precise times and places for important observations of stellar parallax, or the transits of planets. They make the earth's orbit the basis of a well arranged *natural experiment,* as it

were, and take well considered advantage of motions which they can not control. Meteorology might seem to be a science of pure observation, because we cannot govern the changes of weather which we record. Nevertheless we may ascend mountains or rise in balloons, like Gay-Lussac and Glaisher, and may thus so vary the points of observation as to render our procedure experimental. We are wholly unable either to produce or prevent earth-currents of electricity, but when we construct long lines of telegraph, we gather such strong currents during periods of disturbances as to render them capable of easy observation." [1]

Experimentation may, of course, be undertaken with a view to the discovery of meanings. When undertaken in this way it is properly a party of the technique of induction. But experiment is, for the most part, undertaken in connection with the verification of meanings. We experiment in order to test some idea we already have in mind. Consider the following illustration:

"In washing tumblers in hot soapsuds and placing them mouth downward on a plate, bubbles appeared on the outside of the mouth

[1] S. Jevons, *The Principles of Science,* pp. 400-401.

of the tumblers and then went inside. Why? The presence of bubbles suggests air, which I note must come from inside the tumbler. I see that the soapy water on the plate prevents escape of the air save as it may be caught in bubbles. But why should air leave the tumbler? There was no substance entering to force it out. It must have expanded. It expands by increase of heat or by decrease of pressure, or by both. Could the air have become heated after the tumbler was taken from the hot suds? Clearly not the air that was already entangled in the water. If heated air was the cause, cold air must have entered in transferring the tumblers from the suds to the plate. I test to see if this supposition is true by taking several more tumblers out. Some I shake so as to make sure of entrapping cold air in them. Some I take out holding mouth downward in order to prevent cold air from entering. Bubbles appear on the outside of every one of the former and none of the latter. I must be right in my inference. Air from the outside must have been expanded by the heat of the tumbler, which explains the appearance of the bubbles on the outside.

"But why do they then go inside? Cold

contracts. The tumbler cooled and also the air inside of it. To be sure of this, I test by placing a cup of ice on the tumbler while the bubbles are still forming outside. They soon reverse."[1]

In the above example, the variation of conditions was undertaken in order to establish through experimentation the facts which were theoretically required by the hypothesis.

Experimentation is the prevailing method of science and is most frequently undertaken in connection with the establishment of causal relations. Certain probable causes are projected as provisional explanations and the conditions are subsequently varied in order to subject the tentative explanations to experimental testing. John Stuart Mill has formulated in very cogent and precise language five methods for regulating experimental procedure. Logicians are accustomed to treat Mill's methods in connection with induction, but that is because they regard the verification of hypotheses as a part of inductive technique. But inasmuch as we are taking experimental verification as an integral part of deductive proof, it seems advisable to treat these methods in connection with

[1] Dewey, *How We Think*, pp. 70-71.

demonstration. They are a statement of the conditions under which supposed causes are inferred to be true causes. We may now proceed to state and illustrate the methods of Mill.

(a) *The Method of Agreement.* "If two or more instances of a phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree, is the cause (or effect) of the given phenomenon."

The method of agreement serves the primary purpose of eliminating what is irrelevant and accidental. It proceeds on the logical assumption that that cannot be the cause of a phenomenon in the absence of which the phenomenon appears. Take *P* as a given phenomenon. How shall we determine its cause? We take an instance of the occurrence of *P* and note those of its antecedents which are likely or probable causes. Suppose we take the antecedents *a, b, c* as the likely causes. The cause of *P* may be *a,* it may be *b,* or it may be *c*. So far as just this instance is concerned, there is no way of telling which is the cause. The procedure is then to take a number of instances of the occurrence of *P,* selected from over as wide a field as possible. A second instance may reveal *P* preceded by *a, b, m*. We may at once eliminate *c,* because here is an instance of *P* in the absence of *c,* and our assump-

tion is that any antecedent in whose absence the phenomenon occurs is not causally related to it. The further enumeration of instances may lead to the elimination of *b*. Now if in a number of cases it is found that whenever *P* occurs *a* is found as an antecedent, while all the other antecedents vary, each being at least once absent when *P* occurs, we may conclude that *a* is the cause of *P*.

Given *a, b,* and *c* as probable causes to start with, the procedure involving the collection and examination of additional instances is truly experimental. But how do we obtain *a, b,* and *c* to start with? This is the part of inductive procedure for which no hard and fast rules can be given. Each of the probable causes is a guess or a conjecture, or, in more elaborate cases, an hypothesis. Taking the effect, *P,* as an original datum, *a, b, c* are indicated by it. The method is partly one of discovery and partly one of verification. It is a method of discovery in so far as the enumeration of instances enables me by analysis to hit upon the various hypotheses; it is a method of verification in so far as a sufficient tabulation of instances enables me to eliminate all the antecedents except one. This is, of course, another way of saying that induction and deduction cannot be separated in any concrete case.

The method of agreement is useful not only in

working backward from an effect to a cause, it is also useful in working from a cause to its effect. The cause is then taken as the datum, probable effects are conjectured, and instances are collected with a view to the discovery of the sole invariable consequent.

The main purpose of the method is the elimination of the irrelevant. As a basis for the determination of causal relations, the method must be used with great caution. In the first place, one must be on guard against "plurality of causes." A given phenomenon may be produced by a number of causes. In the above case *a* may be the cause of *P* in one case, *b* in another, and *m* in another. The invariable conjunction of antecedent and consequent is not enough to establish causal connection. A second caution to be kept in mind is "incomplete analysis." In the above example, *a* may be just an accidental associate of *P*, and the real cause be yet unanalyzed out. It was thought, for instance, that night air was the cause of malaria, this being an invariable antecedent. The mosquito, which was active only at night, had not then been suspected.

(b) *The Method of Difference.* In order to establish a causal connection, further experimentation is necessary. If an antecedent is causally re-

lated with a phenomenon it should be present when the phenomenon is present and absent when the phenomenon is absent. The method of difference, in taking account of negative instances, provides a double experimental check. It is thus stated by Mill: "If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring only in the former, the circumstance in which alone the two instances differ is the effect, or the cause, or an indispensable part of the cause of the phenomenon."

In administering the method of difference it is necessary to observe two conditions. In the second instance, care must be taken to keep all the circumstances, save the omission of the suspected cause, exactly alike, for otherwise no valid inference could be drawn. And in the second place, it is essential that only one antecedent be varied at a time. When these conditions are complied with it is possible to observe the effect of each antecedent under controlled conditions. Let us suppose the first instance to be represented by *a, b, c,* followed by the effect, *P*. If the supposition is that *a* is the cause, then I take a second instance in which *a* is absent. If, keeping the other circumstances the

same, that is, still having *b* and *c* as antecedents, the phenomenon, *P,* disappears, then I infer that *a* is the cause.

It will be observed that in the method of agreement, ideally considered, all the antecedents are different save one, and in the method of difference all the antecedents are alike save one. In applying the method of difference, one must be on guard against the "composition of causes" and "counteracting" or "interfering" causes. It may be, for instance, that *P* is caused by the combination of *a* plus *b* plus *c;* in that event, the elimination of *a* would be followed by the disappearance of *P,* but *a* would not be the cause of *P*. Or it may be that *b* is the real cause, but *b* is active only in the presence of *a*, so that when *a* is eliminated, the *P* still disappears, although *a* is not its cause.

(c) *The Joint Method of Agreement and Difference.* In the method of difference, we take only two instances, one in which the phenomenon is present and one in which it is absent. A more elaborate method consists in taking two *groups* of instances, a group of instances in which the phenomenon is present, and a group of instances in which it is absent, and examining the grouping of the antecedents in the two sets of instances. For example, in investigating the cause of an epidemic

of typhoid fever, it is just as important to study those who do not have the disease as it is to study those who have. The Joint Method is thus stated by Mill: "If two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance, the circumstance in which alone the two sets of instances differ, is the effect, or the cause, or an indispensable part of the cause, of the phenomenon."

Let us suppose that there is an outbreak of typhoid fever. A sanitary engineer undertakes to investigate the cause of the epidemic. The actual cases of the disease constitute the original data. From past experience the engineer knows that there are several vehicles of typhoid infection. The cause may be traced to an infected water supply, or to the milk supply, or to oysters taken from infected waters. Each of these possible sources, which may be symbolized as *W, M,* and *O,* is a tentative explanation; each is an idea, an hypothesis to be further investigated. As ideas they are governing concepts in terms of which the investigation goes on. The problem is chiefly one of verification since it requires on the part of the engineer but little inductive resourcefulness to hit upon these possible

interpretations. The engineer proceeds by taking a group of instances in which the phenomenon is present, that is, cases of people who have the disease, examining the antecedents, that is, ascertaining the exact source of the water and milk supply and asking whether they had eaten oysters and if so where they had got them. Let us suppose (and we will make the supposition over simple for purposes of illustration) the results of the investigation to be as follows: W equals city water supply; W' equals water from a well in the town square; W'' equals water in a private cistern. M equals milk from Cloverland Dairy, M' milk from Smith Farm Dairy, M'' milk from Harrison Farm Dairy. O equals oysters from Brown's grocery, O' oysters from the city market, and O'' oysters served at the town hotel. P, P', and P'' represent separate cases of the disease.

W	M	O	P
W'	M'	O	P'
W''	M''	O	P''

The engineer might conclude from this that the oysters were the cause. However, he does not stop here. He takes a second group of instances composed of those who do not have the disease, and examines the conditions antecedent in their experi-

ence. The results of this second investigation are as follows:

W	M	—	—
W'	M'	O'	—
W''	M''	O''	—

Combining the results of both investigations, the engineer concludes that the oysters from Brown's grocery were the cause of the epidemic, since they were everywhere present when the phenomenon was present and everywhere absent when the phenomenon was absent, and each of the other antecedents being once present when the phenomenon was absent, and at least once absent when the phenomenon was present.

It should be remembered that the Joint Method is open to all the difficulties of both the methods of Agreement and Difference taken separately.

(d) *The Method of Concomitant Variations.* Mill's statement of this method is as follows: "Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon, or is connected with it through some fact of causation." The logical assumption underlying this method is that that cannot be the cause of a phenomenon which varies when the phenom-

enon is constant or which remains constant when the phenomenon varies. The method is especially applicable to the physical sciences. Science is most at home with the concept of quantity. When phenomena can be reduced to exact measurement they are most amenable to scientific treatment. Whenever there is causal connection between phenomena which are capable of being expressed quantitatively, the amount of intensity or energy represented in an effect is quantitatively equivalent to definite amounts of intensity or energy in the cause. When variations in a series of antecedents and consequents can be reduced to a common quantitative denominator, there is a more precise and exact basis for causal inference. For example, when a barometer is carried up a mountain it is observed that its scale readings vary proportionately to the altitude. Now both altitude and the readings on the scale of the barometer are phenomena which can be expressed in terms of quantity. It is, therefore, possible for one to compare amounts of quantity in the antecedent with amounts of quantity in the consequent, and having a common basis of comparison, to arrive at an inference of causal connection.

(e) *The Method of Residues.* The method is stated by Mill as follows: "Subduct from any phe-

nomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents."

4. GUIDANCE OF DEDUCTIVE THINKING. Effective deductive thinking requires a funded stock of experience and information, a wide collection of major premises. Hypotheses are tested in the light of a wider range of ascertained facts and principles. There is a vast background of conceptual information that *determines* and *regulates* what and how we think in any particular instance. Deduction means *using* this information in the most effective way.

A second qualification for effective deductive thinking is found in the power of steady vision to see into the future consequences of an hypothesis. Implication is the heart of deduction. Reasoning from a principle takes the following form: If the principle is true, certain implications should follow from it. What are they? One must have the power to visualize future consequences, to project in the imagination future results. Thinking means to forestall, to foresee, to forecast. The forces we encounter in action we must first envisage in thought. Things which are going to happen can in this way be made to influence and guide present

action. One must use his imagination to picture to his mind in the most vivid and intense and real way the things which are likely to happen in case a given idea is accepted. It often happens that if we had only stopped to *realize* the actual and concrete *results* of a plan we would have acted quite differently. It is in this sense that reasoning is described as "mental rehearsal." On the deductive side the rehearsal takes the form of a series of conceptual inferences. A physician, for example, has to examine the hypothesis that a given illness is typhoid fever. What he does is to think out into detail all that typhoid fever implies. He must translate the concept into all that it concretely stands for. Ability to visualize the implications of our general ideas is a requisite for deductive thinking.

A third qualification is found in the ability to compare theoretical requirements and logical implications with the facts as they are presented in actual experience. If this is typhoid fever, certain facts and conditions *ought* to show themselves. One must compare the facts with the theory. You think of the concept of fever to ascertain what should be expected, and then look at the patient to see if the symptoms agree or comply with the theoretical requirements. Responsible thinking de-

pends on the power to compare facts with theory. One must have the patience to return again and again to the facts of the problem and to look at them from the standpoint of possible explanations. Darwin has said that a good observer must be an active theorizer. The converse is just as true; a good theorizer must be an active observer. Plans and projects must be worked out in terms of the facts and conditions available for their realization.

Finally, the importance of definition should be related to the control of deductive procedure. Since deduction consists in the operations of conceptual inference, the process is facilitated by having meanings clearly defined. A clear and comprehensive grasp of meanings is prerequisite to the deduction of implications from them.

5. FALLACIES OF DEDUCTION. Two fallacies, essentially deductive in character, may here be noted.

(a) *Fallacy of Accident.* We have already met with the converse fallacy of accident; it is an inductive fallacy and occurs in connection with inference from the particular to the general. The fallacy of accident is just the reverse; it is a deductive fallacy and arises when an inadmissible inference is made from the general to the particular. Each of us has a body of generalized knowledge which is utilized in the solution of particular

problems. The essence of deduction consists in the applications of general ideas to particular instances. But this application cannot be made *überhaupt.* In passing from the implications of an hypothesis to the original data in question, care must be taken to see that there are no extenuating circumstances or data of a unique or accidental character which would render the application of the hypothesis inadmissible in *this particular* instance. The proposition, whatever is worth doing at all is worth doing well, is true in general. In this connection, it is interesting to recall the reply made by Herbert Spencer to his antagonist at billiards: "I play billiards for recreation; the way you play seems to indicate a wasted life."

The following examples will clarify the nature and meaning of the fallacy:

"Freedom of speech is one of our most sacred privileges; therefore debate in the United States Senate should be unrestricted."

"The holder of some shares in a lottery is sure to gain a prize, and as I am the holder of some shares I am sure to gain a prize."

"Epimenides, the Cretan, says that all Cretans are liars. But since Epimenides himself is a Cretan it follows that he himself is a liar. Therefore,

we can not believe him, and it is not true that all Cretans are liars."

(b) *Fallacy of Division.* The fallacy of division, the reverse of the fallacy of composition, arises in connection with an inference from the truth of the whole to the truth of the part. A body of evidence taken as a whole might be sufficient to convict, while no one of the arguments taken by itself would be convincing.

QUESTIONS

1. Give a detailed description of the deductive movement of thought.

2. How do you correlate "visionary" thinking with the failure to think deductively?

3. In what sense does deduction become a method of discovery?

4. In the forward movement of thought we pass from data to meanings, and in the backward movement from meanings to data. Are the data and meanings which enter into the second movement exactly the same as those which enter into the first? Explain.

5. Explain the function of ideas as instruments of prediction, control, and criticism.

6. In the consideration of observation, it was seen that ability to observe properly was dependent upon the breadth of past experience. What is the analogy of this with regard to inference?

7. What are the two steps involved in the verification of an hypothesis?

8. What are the two sub-divisions of the second step?

9. State and explain Mill's experimental methods.

10. Why are these methods presented in connection with verification?

11. What logical assumptions underlie these methods?

12. What are the difficulties which must be taken into account in the administration of these methods?

13. Explain Mill's use of the following terms: Phenomenon, Instance, Antecedent, Circumstance.

14. What are the advantages of the method of difference over the method of agreement?

15. What are the advantages of the joint method over the method of agreement and the method of difference?

16. How do you distinguish between observation and experimentation?

17. Is astronomy an observational or an experimental science?

18. Would you classify anthropology and geology as observational or experimental?

19. Is experimentation a necessary part of the definition of science?

20. Is mathematics a science?

21. What practical considerations can be offered for the guidance of deductive thinking?

22. Explain the fallacies of accident and of composition. Why are they classed as deductive fallacies?

ILLUSTRATIONS

1. Construct an example to illustrate deduction as a backward movement of thought.

2. Illustrate the instrumental function of ideas with reference to (a) control; (b) prediction and (c) criticism.

3. Illustrate what is meant by the deduction of the implications of an hypothesis.

4. Illustrate the comparison of the implications of an hypothesis with the facts by means of observation.

5. Illustrate the comparison of the implications of an hypothesis with the facts by means of experimentation.

6. Illustrate each of Mill's experimental methods.

7. Give illustrations of faulty thinking due to failure to guard against (a) plurality of causes; (b) incomplete analysis; (c) composition of causes; (d) interfering causes.

8. Cite from chemistry an illustration of "catalysis."

9. Illustrate the fallacies of accident and division.

EXERCISES

1. Do you think that the second step in the verification of an hypothesis should be treated as an integral part of deduction?

2. Give the reasons for and against this view.

3. Compare the view given of verification as a part of deduction with the description of method as outlined by Minto on page 362.

4. Make a logical analysis of the illustration, "What should money cost?"

5. Make a logical analysis of the soap bubble illustration given on page 365 *seq.*

6. Is experimentation as a scientific method prevailingly inductive or deductive? Give reasons for your answer.

7. Why are Mill's methods termed "experimental"?

8. Basing your answer on the steps involved in verification, how would you define "truth"?

9. Make a logical analysis of the following:

> " 'Can living beings come into the world without having been preceded by beings similar to them?' Thus he (Pasteur) stated his problem. Locating the question more

definitely, he asked himself whence the minute organisms which the microscope disclosed in previously sterile liquids had come. Can these have come in from the air, and if so can they be there discovered? If such germs exist in the atmosphere, it should be possible to gather them from it, and to this attempt Pasteur first addressed himself. By drawing a current of air through a cotton filter, he found deposited on the latter germs and spores like those under consideration. Had he proved his point? No, for the cotton was itself an organic substance, and might therefore have given rise to these organic particles. Pasteur substituted a mineral filter, asbestos, for the cotton, and again an air current left its deposit."[1]

10. Make a logical analysis of the description of an experiment undertaken by Pasteur in order to test the hypothesis of "heterogenesis":

"I place a portion of the infusion into a flask with a long neck. . . . Suppose I boil the liquid and leave it to cool. After a few days, mouldiness or animalculae will develop in the liquid. By boiling I destroyed any germs in the liquid or against the glass; but that infusion being again in contact with air, it becomes altered as all infusions do. Now suppose I repeat this experiment, but that before boiling the liquid I draw the neck of the flask into a point, leaving, however, its extremity open. . . . Now the liquid of this second flask will remain pure. . . . What difference is there between these two cases? . . . The only difference between them is this: in the first case the dusts suspended in air and their germs can fall into the neck of the flask and come into contact with the liquid, where they find appropriate food and develop. Thence microscopic

[1] Columbia Associates, *An Introduction to Reflective Thinking*, pp. 69-70.

beings. In the second flask, on the contrary, it is impossible, or at least extremely difficult, unless air is violently shaken, that dusts suspended in air should enter the vase. They fall on its curved neck.

"This experiment is full of instruction. For this must be noticed, that everything in air save its dusts can easily enter the vase and come in contact with the liquid. . . . Only one thing cannot enter easily, and that is dusts suspended in air. And the proof of this is, that if I shake the vase violently two or three times in a few days it contains animalculae or mouldiness. Why? Because air has come in violently enough to carry dust with it."[1]

11. In the two foregoing illustrations, was experimentation undertaken for the purpose of discovery or proof? If discovery, discovery of what? If proof, proof of what?

12. Make a logical analysis of the following:

"The honor of placing the kinetic theory of heat upon a sound experimental basis belongs almost exclusively to the Englishman, J. P. Joule. He elaborated the consequences of that theory, and then actually discovered by physical measurements in his laboratory that those consequences did take place. If heat is not a fluid, but is rather the energy of molecular motion within a body, and if those molecular movements take place in accordance with the ordinary mechanical laws of motion, then, when mechanical energy is expended upon a body, say through pressure upon a gas, and is transformed into heat, or the increased motion of the molecules within that body, the energy which disappeared in the act of compression should exactly equal the energy which appears in the increased motion of the molecules, or heat. Conversely, the energy of molecular motion which disappears when a gas expands again

[1] Columbia Associates, *Introduction to Reflective Thinking,* p. 71.

(or the heat which it loses on expansion) should reappear as mechanical work done by that expansion. For on the molecular theory we are dealing not with two different kinds of energy, mechanical energy, or the ability to perform work, and an energy of a different sort entirely, heat; but rather with mechanical energy on two different scales, the motion of large bodies, and the motion of very small bodies, or molecules. In other words, the theory could not be regarded as complete until it had been shown that, in the production of work from heat, a certain quantity of heat disappeared and ceased to exist as heat; and that this quantity was the same as that which could be generated by the expenditure of the work produced.

"This actual quantitative determination of what is called the 'mechanical equivalent' of heat was the task of Joule, and in experimentally verifying that equivalence he conclusively demonstrated the whole kinetic theory of heat."[1]

[1] Columbia Associates, *An Introduction to Reflective Thinking*, pp. 133-134.

CHAPTER THIRTEEN

THE SYLLOGISM

In text-books on formal logic, deduction is identified almost exclusively with the syllogism. We shall now attempt to give a brief description of the syllogism, its forms, structure, laws, and uses, and then seek to relate it to the analysis of reflection described in the foregoing pages.

The syllogism has been defined by Professor Creighton as follows: "We may define the reasoning expressed in a syllogism as a judgment which has been expanded so as to exhibit the reasons by which it is supported."[1] As an illustration we may take the following categorical syllogism:

> All Persian rugs are expensive.
> This rug is a Persian rug.
> Therefore, this rug is expensive.

The conclusion, "this rug is expensive," is a judgment the truth of which rests on the two foregoing statements. The three propositions taken in their

[1] J. E. Creighton, *An Introductory Logic,* p. 39.

relations express a conclusion together with the grounds which support it.

We may also give the definition of the syllogism which was formulated by Aristotle: "A syllogism is a discourse wherein certain things being admitted, something else, different from what has been admitted, follows of necessity because the admissions are what they are."[1] Commenting upon this definition, A. E. Taylor says: "The last clause shows that Aristotle is aware that the all-important thing in an inference is not that the conclusion should be novel but that it should be proved. We may have known the conclusion as a fact before; what the inference does for us is to connect it with the rest of our knowledge, and thus to show *why* it is true."[2]

The syllogism, therefore, is not a description of the process of reflection, but a statement of the *results* of reflection. Its purpose is not discovery, but proof; and it is for this reason that it is properly treated in connection with deductive verification. And even in this respect the syllogism does not deal with the processes involved in verification, but with the manner in which propositions are ar-

---

[1] *The Prior Analytics,* Bk. I, Chap. I, sect. 7. The translation is that of A. E. Taylor.

[2] A. E. Taylor, *Aristotle,* p. 25.

ranged so as to compel assent. We have already said that it is one of the purposes of logic to furnish us with a basis of criticism, that is, with a technique by means of which we can tell whether our conclusions are *true.* Let us take an example: Is this a Persian rug? Now what would I have to know in order to answer Yes or No, and be *absolutely certain* that my answer was correct? To answer Yes, I would have to know (1) that all rugs that have the marks so and so are Persian; and (2) that this rug has the marks so and so. In order to answer No, I would have to know (1) that no rugs having the marks so and so are Persian; and (2) that this rug has the marks so and so. In both cases when I know the two preliminary propositions, I know with certainty the conclusion. In neither case is the conclusion inferred from the premises; the premises merely invalidate or confirm the conclusion. A syllogism, therefore, represents the form which the propositions take when combined in such a way as to yield truth. In the above examples, the establishment of the two preliminary propositions (premises) is the work of prior reflection. The syllogism has nothing to do with their derivation. It merely expresses in a formal statement the results of reflection *after* the premises have already been established. It is a

convenient formal method for testing the validity of our beliefs, and shows the manner in which those beliefs are connected with other knowledge when that connection is such as to compel assent. Its practical use lies largely in the fact that it aids us in making explicit the grounds supporting our beliefs.

There are three types or forms of syllogisms, the distinctions between them being made on the basis of three kinds of propositions. Propositions are classified into hypothetical, disjunctive, and categorical. A hypothetical proposition makes a statement subject to a condition; for example, if the weather is clear, the ship will sail tomorrow. A disjunctive proposition is a statement of alternatives; for example, the ship will sail either today or tomorrow. A categorical proposition is a declarative sentence, an unconditioned statement of fact; for example, the ship will sail tomorrow. Thus we have three forms of statement: if x, then y; x is either y or non-y; x is y. Corresponding to these three forms of propositions, there are three types of syllogisms, the hypothetical syllogism, the disjunctive syllogism, and the categorical syllogism, dealing respectively with hypothetical, disjunctive, and declarative statement.

1. THE HYPOTHETICAL SYLLOGISM. The hypo-

thetical syllogism is composed of three propositions, a major premise, a minor premise, and the conclusion. The major premise is a hypothetical proposition, the minor premise and the conclusion being categorical in form. The hypothetical major premise is composed of two parts, an "if" clause, technically called the antecedent, and the "result," technically called the consequent. Thus, if this substance is carbon (antecedent), it will burn (consequent). The categorical minor premise may sustain one of four relations to the major premise; it may either affirm or deny the antecedent; or it may affirm or deny the consequent. Thus we may say: this substance is carbon; this substance is not carbon; this substance will burn; this substance will not burn. Of these four possible minor premises, two will give valid conclusions and two will give false conclusions. The valid conclusions will be found to follow when the antecedent is affirmed or when the consequent is denied; false conclusions follow when the antecedent is denied or when the consequent is affirmed. Accordingly, the following rules may be stated: For valid conclusions, either affirm the antecedent or deny the consequent. The two corresponding *fallacies* are termed *Denying the Antecedent* and *Affirming the Consequent.*

Examples may serve to clarify the above state-

ments. In order to familiarize himself with the technique of the hypothetical syllogism the student should work out for himself the following examples:

(a) "Except ye repent, ye shall all likewise perish." As I have repented, I shall be saved.

(b) If this is a case of typhoid fever, the symptoms *a, b, c, d, e, f,* should be present. Since these symptoms are present, we may conclude that this is a case of typhoid fever.

(c) If the appearance of bubbles on the outer rim of a glass when taken from hot soap suds is due to the expansion of the cold air when heated by the hot glass, then a glass containing air of the same temperature as the glass should show no bubbles. Experiment shows this to be so. Hence we may conclude that the expansion of air due to heat is the cause.

(d) If this is a Persian rug, it will have the traits so and so; an examination of the rug reveals the traits so and so; it is, therefore, a Persian rug.

(e) If Logic is an empirical science, the outstanding traits of reflection, for example, the distinction between data and meaning, the investigation of the grounds supporting belief, the examination of evidence, the operation of conceptual inference, *etc.,* should be open to description and

identification. A study of reflection shows that these characteristic traits can be thus identified and described. Consequently we are right in our view that Logic is an empirical science.

(f) "Hence, the general principles of the hypothesis of evolution lead to the conclusion that the horse must have been derived from some quadruped which possessed five complete digits on each foot; which had the bones of the forearm and of the leg complete and separate; and which possessed forty-four teeth, among which the crowns of the incisors and grinders had a simple structure, while the latter gradually increased in size from before backwards, at any rate in the anterior part of the series, and had short crowns.

"And if the horse has been thus evolved, and the remains of the different stages of its evolution have been preserved, they ought to present us with a series of forms in which the number of the digits becomes reduced; the bones of the forearm and leg gradually take on the equine condition, and the form and arrangement of the teeth successively approximate to those which obtain in existing horses.

"Let us turn to the facts and see how far

they fulfill these requirements of the doctrine of evolution.

[Research and investigation lead to the discovery of these traits.]

"Thus, thanks to these important researches, it has become evident that, so far as our present knowledge extends, the history of the horse-type is exactly that which could have been predicated from a knowledge of the principles of evolution. . . .

"This is what I mean by the demonstrative evidence of evolution. An inductive hypothesis is said to be demonstrated when the facts are shown to be in entire accordance with it. If that is not scientific proof, there are no merely inductive conclusions which can be said to be proved. And the doctrine of evolution, at the present time, rests upon exactly as secure a foundation as the Copernican theory of the motions of the heavenly bodies did at the time of its promulgation. Its logical basis is precisely of the same character—the coincidence of the observed facts with theoretical requirements.

"The only way of escape, if it be a way of escape, from the conclusion which I have just indicated, is the supposition that all these dif-

ferent equine forms have been created separately at separate epochs of time; and, I repeat, that of such an hypothesis as this there neither is, nor can be, any scientific evidence; and assuredly, so far as I know, there is none which is supported, or pretends to be supported, by evidence or authority of any other kind." (Huxley)

We may now turn to the status of the hypothetical syllogism in reflection. The hypothetical syllogism is an exact representation of the deductive movement of thought. We have seen that there are two steps involved in the verification of hypotheses: (1) Deduction through conceptual inference of the implications of the hypothesis; (2) Comparison of the theoretical requirements (implications) with the actual facts as either (a) given in observation or as (b) determined by experimentation. These two steps constitute deductive proof.

Let us first determine the logical character of the major premise. The major premise, as we have seen, is composed of a hypothetical proposition. The antecedent represents the hypothesis. The consequent represents the implications of the hypothesis. For example, suppose there is a question

regarding a given substance. The supposition is made that it is carbon. Carbon, therefore, is an inductive guess, an explanatory concept, an hypothesis. In verifying the hypothesis, we first deduce its implications. We say, if carbon, then it should burn. The trait "burning" is what is implied on the assumption of the truth of the hypothesis. We can then formulate the proposition: if this substance is carbon, it will burn.

We may now turn to the logical character of the minor premise. The minor premise corresponds to the second step in verification. The thought process shifts from conceptual inference to observation. We go back to the data and re-examine them with a view to determining their agreement with the theory. Simple observation reveals the fact that the substance burns. The additional datum "burning" is discovered through observation, the process being guided by the deduction of that trait as an implication.

The logical character of the conclusion is found to consist in the comparison between the theoretical requirement and the facts in the case. If there is harmony between fact and theory, the theory is said to be true; if there is no harmony between them it is said to be false. The conclusion is a knowing. I now know that this substance is carbon.

We have already seen that knowing goes on in terms of data and meaning; they are the materials of reflection. The hypothesis together with its implications constitutes meanings. They are general in character. The additional fact, *e.g.,* burning, is a datum of observation. It is a particular. It is in terms of these two cooperative instrumentalities, data and meaning, particular and general, that knowledge is acquired.

In this illustration the minor premise represents the data as they are given in observation. Let us now take an illustration in which the second step in verification involves experimentation. We may cite the refutation of the ancient "caloric" theory of heat:

> "Most important were the heat of compression and the heat of friction. When you take a gas and compress it, it becomes much hotter than before, as anyone who has ever pumped up a tire knows. Where does this heat come from? Not from outside as in most other cases of a rise in temperature, because the surroundings don't get any cooler, as they would if some caloric passed into the gas. It must come from inside the gas itself, and hence, if caloric is a fluid, it must have been there all along

without our knowing it. Similarly, where does the heat that appears when two bodies are rubbed together come from? It also must have been hidden in the bodies. If caloric is fluid, it must be able to lie latent or hidden within bodies on occasion. The explanation which the calorists offered of the appearance of heat on friction or compression was that some of this 'latent' caloric was squeezed or ground out of the bodies concerned and became 'sensible' or apparent. Obviously, if such was the case, if you rubbed long enough you would naturally reach a limit to the caloric you could rub out, because you would either squeeze all of it out or at least as much as you could. In 1798, Benjamin Thompson, Count Rumford, endeavored to find how much he could extract. He made a metal cannon rotate in a box containing water, and by the friction of a revolving blunt borer driven by horse-power the water was heated to boiling in two and a half hours. There seemed no limit to the caloric he could produce. He exclaims, 'What is heat? Is there any such thing as a caloric fluid? . . . Anything which any insulated body, or system of bodies can continue to furnish without limitation, cannot

possibly be a material substance; and it appears to me to be extremely difficult if not quite impossible, to form any distinct idea of anything, capable of being excited, and communicated, in the manner the heat was excited and communicated in these experiments, except it be MOTION.' "

Let us examine the logical form of the reasoning. That heat is a substance called "caloric" is the hypothesis. The syllogism expressing the reasoning is as follows: If heat is a caloric fluid, then there is a limit to the amount that can be extracted Experiment shows that there is no limit; therefore, heat is not a caloric fluid. The major premise represents the hypothesis and its implications. But in this instance we can not turn to observation to determine the factual existence of the implications. They do not as yet exist, and so one must resort to experimentation in order to produce them. The results of the experiment deny the consequent, and so the hypothesis is said to be false. To generalize, we may say that every experiment functions logically as the minor premise of a hypothetical syllogism. Its aim is to produce the data which will

---

[1] Columbia Associates, *An Introduction to Reflective Thinking*, pp. 131-132.

either confirm or refute the hypothesis in question. To summarize, then, the major premise represents meaning, the minor premise represents data, the conclusion, the knowledge which is gained through them as means.

It should be noted that the verbal formulation of the syllogism expresses the results of thinking. The inductive processes involved in the formulation of the antecedent, the conceptual inferences involved in the deduction of implications as expressed in the consequent, the subsequent processes of observation and experimentation the results of which are expressed in the minor premise, are taken for granted. That is, they have already been determined by previous intellectual effort and the syllogism merely expresses in a convincing form the results of reflection. From this we conclude that the syllogism is not a description of the operation of thought, but a statement of the results of thinking in a form that compels assent.

Having now determined the status of the hypothetical syllogism in reflection, we may proceed to an examination of the logical character of hypothetical proof. To obtain a valid conclusion from hypothetical reasoning, we have seen that we must either affirm the antecedent or deny the consequent. The chief value of the hypothetical syllogism is,

I think, negative in character and consists in the elimination of false hypotheses. That is to say, when the results of observation or experimentation do not conform to the implications deduced from the hypothesis, the hypothesis is then discarded. The negative character of hypothetical proof is logically unassailable. For example, if the office has been burglarized, then valuable articles will be missing; these valuable articles are not missing; therefore the office was not burglarized. Now this conclusion is logically valid. The hypothesis of burglary can, therefore, be discarded. Most hypothetical arguments take the form of affirming the consequent. This does not mean that the hypothesis is false; it means only that the argument is not logically conclusive. If, for instance, in the above example, it could be established through observation that the valuable articles were missing (affirming the consequent), the inference that the office had been burglarized would be highly probable but not logically certain. The articles might be missing for other reasons; what we have above described as "plurality of causes" would have to be taken into account. In order to arrive at positive confirmation of the hypothesis through the affirmation of the consequent, it would be necessary to have eliminated all the other hypotheses, and to

know that burglary was the *only* other alternative. The example given from Huxley (p. 393 above) would be a case in point. It is difficult, therefore, to prove by positive evidence that an hypothesis is true; the most that can be done is to discard all rival hypotheses, and to seek assurance that the remaining hypothesis is the *only* one left. In this case, the conclusion that the hypothesis is true rests on a disjunctive syllogism, a form of reasoning that we will examine later.

It should be noted, however, that in cases where there is a *binding* or *necessary* connection between antecedent and consequent, either physical as in the case of cause and effect, or logical as in the case of ground and consequent, it is logically valid to deny the antecedent or affirm the consequent. In the above example, for instance, there is no necessary connection between missing articles and burglary. But in the following case: If the thermometer drops below thirty-two degrees (and there are no interfering causes), the pond will be frozen over; the pond is frozen over; therefore, the thermometer must have dropped below thirty-two degrees; the conclusion is valid because there is a necessary connection of physical cause and effect between a drop in temperature and the freezing of water. Or again, take the following: If this is an equilateral

triangle, it is also equiangular; it is not equilateral, and hence not equiangular. The denial of the antecedent yields a valid conclusion because there is necessary logical connection between the concepts equilateralness and triangularity.

Of course one could, in hypothetical form, reason forward from data to meaning. He could say that if certain articles are missing, then burglary. Observation establishes that the articles are missing, and the conclusion that burglary is the cause is valid. But this is only a case of complex *perceptual* inference. There has been only *indication.* While such a procedure is logically valid, it is not a case of deduction at all; there has been no hypothesis set up to investigate; there has, in the strict sense of the word, been no reflection at all. The heart of reasoning consists in conceptual inference, and where there are no implications from an hypothesis (deductions to be confirmed by a backward movement from meaning to data) there is no genuine reflection.

2. THE DISJUNCTIVE SYLLOGISM. When reasoning takes the form of affirming or denying the antecedent, it moves within the limits of perceptual inference. This is equivalent to saying that reasoning arises only when we undertake to affirm or deny the consequent on the basis of deduced conse-

quences. The reasoning, as we have seen, is logically valid when the consequent is denied. This means that the conclusion is negative, and this, furthermore, is equivalent to saying that the main purpose of the hypothetical syllogism is the elimination of false hypotheses. It is easy to prove that a conclusion is false, but it is not so easy to prove that it is true. But we are not to conclude from this that reasoning is useful only in the detection of error and not in the establishment of truth. Much of reflection, both in practical deliberation and in scientific research, takes the form of affirming the consequent.

In those cases where the antecedent is the sole, invariable antecedent, the conclusion derived from the denial of the antecedent is logically unassailable. But what is to be our intellectual procedure in those cases where there is the possibility of a plurality of causes? If the hypothetical syllogism were the only form of reasoning, the mind would be left in permanent doubt. Positive knowledge would lie in the escape from error, and all science would rest on faith. All we could then say would be that in the absence of contradiction it is justifiable to believe.

It is at this point that the disjunctive syllogism appears as a supplement to the hypothetical. Let

us first state the character of disjunction. We must distinguish between saying that the cause of a phenomenon may be *a,* or may be *b,* or may be *c,* and saying that it is either *a,* or *b,* or *c.* In one case, we are dealing with possibilities, or it may be with the plurality of causes; in the other case we are dealing with alternatives. Now disjunction is concerned with alternatives.

The simplest form of disjunction occurs when the alternatives are contradictories. The logical character of contradiction is expressed in the law of excluded middle. This law may be stated as follows: Between contradictories there is no middle ground. Contradictory propositions are such that if one is true the other is necessarily false, or if one is false, the other is necessarily true. This, as we have already seen, is the principle underlying dichotomy. A student, for example, has either passed a course, or he has not passed it. If it is false that he has not passed it, then it is true that he has passed it; and conversely, if it is false that he has passed it, it is true that he has not passed it.

In this connection, it is important to distinguish between contradictories and contraries. Contrary propositions are such that if one is true, the other is necessarily false, but both may be false. In other words, there is a middle ground between contraries.

Thus black and white are contraries, but not contradictories. If it is true that a thing is black, it is false that it is white; but it may be neither but some color in between. Much disjunctive reasoning is fallacious because it deals with contraries. Thus the Stoics undertook to classify all men as either saints or sinners. No inference can be drawn from this classification because most men belong partly in both classes.

Disjunctive arguments are valid, then, when the alternatives are contradictories. The disjunctive syllogism takes the following form:

> P is either x or non-x;
> P is not non-x;
> Therefore, P is x.

The minor premise, of course, may either affirm or deny either of the contradictory terms in the major premise.

It is obvious, of course, that disjunction may deal with more than two alternatives which are contradictory in character. Thus:

> P is either x or y or z;
> P is neither y nor z;
> Therefore, P is x.

In this form, care must be taken to see that x, y,

and z are the only possible alternative explanations of P and that they are mutually exclusive. The real intellectual problem is concerned with the establishment of the alternatives. This requires much preliminary thought and analysis. After the alternatives are established, the drawing of the conclusion is almost automatic. This is another way of saying that the syllogism expresses the results of thinking, and is not concerned with the process of thinking.

The hypothetical and disjunctive syllogism are two forms of expressing the same thing. This may be seen by re-expressing the foregoing syllogism in hypothetical form:

> If P is neither y nor z, then it is x;
> P is neither y nor z,
> Therefore, P is x.

We are now ready to ask a more penetrating question. Does all proof rest on elimination? That is, have we no other reasons for believing that P is x than that it is not y and that it is not z? This proof would be all that the logical mind could ask if the alternatives were contradictories. But where there are a number of alternatives, the possibility would always be present that the enumeration of alternatives had not been exhaustive. But even granting that the alternatives are exhaustive, have

we no better reason for accepting x than by saying that we have eliminated y and z? Those who answer this question in the negative are forced to say that disjunction is the basis of all induction, and that elimination is the basis of all truth. Such a view, for example, is expressed by Professor Creighton.[1] The further discussion of this problem will be postponed until after we have discussed the categorical syllogism.

3. THE CATEGORICAL SYLLOGISM. The categorical syllogism has always received extensive treatment in text-books on Formal Logic. We may now proceed to an examination of its structure, use, and place in reflection.

The categorical syllogism is composed of three categorical propositions, called the major premise, the minor premise, and the conclusion. For example:

> The geranium has five pointed sepals (major premise).
> This plant is a geranium (minor premise).
> This plant has five pointed sepals (conclusion).

The syllogism has three terms, the major term, the minor term, and a middle term. The major term

---

[1] See J. E. Creighton, *An Introductory Logic*, p. 199.

is the predicate of the conclusion. It is called the major term because it is the thing finally affirmed; and this affirmation is the object of the inquiry, the thing finally known and, therefore, of major interest. That premise is always the major premise which contains the major term. The minor term is the subject of the conclusion, and that premise is the minor premise which contains the minor term. The middle term, the basis of comparison, appears in both premises, but not in the conclusion. For example: Gold is not a compound substance; for it is a metal, and none of the metals are compounds. "Gold is not a compound substance" is the conclusion. It is stated first, and the reasons (premises) are stated afterwards. "None of the metals are compounds" is the major premise because the term "compound substance" is the predicate of the conclusion. And in a similar way we know that "Gold is a metal", is the minor premise since the term "gold" appears in this proposition and in the conclusion as subject.

Let us now seek to determine the status of the syllogism in reflection. The major premise represents "meaning"; the minor premise represents "data"; the conclusion expresses "knowledge." As we have already seen, data and meaning are the things we know with; they are the cooperative in-

strumentalities in terms of which knowing goes on. For example: What kind of rug is this? Well, I make the conjecture that it is a Persian rug. This is an inductive hypothesis. I proceed to verify it. I reason as follows: If this is a Persian rug, it will have the traits so and so (the traits so and so being the implications deduced from the concept); I turn to observation and look for the traits so and so (the second step in the process of verification); on comparison of the theoretical implications with the facts, I find complete agreement; I conclude that it is a Persian rug. The actual process of reflection deals with the derivation of the hypothesis, with deduction of implication from it, and with the comparison of theory with fact (of meaning with data). These are processes involving inventiveness, skill in deduction, accurate observation, *etc.* If, now, I wish to express the *results* of my thinking in a form that will be logically compelling, I formulate the results syllogistically. I say: All rugs that have the traits so and so are Persian rugs (general or conceptualized knowledge); this rug has the traits so and so (particular data determined by observation); therefore, this rug is a Persian rug (conclusion known through the medium of meaning and data).

It was just this interpenetration of data and

meaning, the particular and the general, minor premise and major premise, that Plato called "the everlasting quality of reasoning." Data and meaning are not objects of knowledge, but are means to knowing. And every inference which can be termed a knowing involves a combination of the two. The cooperative rôle of data and meaning, and their necessary relation to knowledge, may be stated in terms of a rather famous quotation from the philosopher, Immanuel Kant: "Perceptions [data] without conceptions [meaning] are blind, while conceptions without perceptions are empty." One of the rules of the syllogism is that from two particular premises no conclusion can be drawn. This means that knowing does not and cannot go on in terms of data alone (data always being particular). A general meaning is present either explicitly or implicitly, in every cognitive inference. For example, one may say: I know John by his walk. It would seem that the knowledge is acquired from data alone. But it will be readily seen that a general meaning is implied, a meaning without which no inference could be drawn. If John walked one way today, another way tomorrow, and never on any two occasions walked the same way, we would have a series of different data, and from these no conclusion could be drawn. What is im-

plied is that John has a characteristic way of walking. However abbreviated be the inference, the expanded reasoning is as follows: John always walks a certain way (generalized meaning); this is an example of that way (datum of observation); therefore this is John (comparison of data and meaning). Of course it should be noted that the above syllogism contains the formal fallacy of *Undistributed Middle.* This does not mean that the conclusion that this is John is necessarily false; it only means that I *may* be mistaken; there may be others besides John who walk in that characteristic way. Of course if I knew that John, and that no one who was not John (further generalized meaning), walked that way, my inference would be valid.

The last sentence implies a disjunctive syllogism. It may be expressed as follows:

> This walk is either John's walk or it is the walk of one who is not John.
> This is not the walk of one who is not John.
> Therefore, this walk is John's walk.

This brings us back to the theory of elimination, and to the question: Have we any reason for believing that a thing is so other than the rejection of rival reasons? The eliminative theory is logically convincing when we are sure that we have enu-

merated all the alternatives and when we know that the alternatives are mutually exclusive. But we can never be sure that we have an exhaustive enumeration of the alternatives. And so on the eliminative theory, we might say of certainty what Schopenhauer said of materialism, even at its birth it has death in its heart. The lurking possibility of error is invincible. What shall we say of this?

In the first place we must recognize that the eliminative theory, with its ineradicable element of risk, is descriptive of much that lies within the field of scientific explanation. Many scientific hypotheses are merely "working" hypotheses and are tentatively held. The scientist is ready to consider new hypotheses or to modify or discard old ones upon the appearance of new and contradictory data.

But, on the other hand, there is much within science which may pass for positive truth. The view that this is so rests on the fact that "laws" and "principles" are not external to the facts. If the view that induction through scientific analysis is a correct account of the establishment of scientific generalizations, it means that the generalizations are read out of the facts. They are statements of the underlying order and connection *inherent within* the facts. Having first abstracted them

from the facts, they can then be read back into the facts. Take, for example, the soap bubble illustration given on page 365. The appearance of the bubble on the outer rim of the glass and its subsequent movement to the inner rim is explained in terms of the physical principles of expansion and contraction in response to heat and cold. This explanation is accepted, not as the result of the elimination of rival explanations, but as being an explanation in its own right. It is a positive proof because the principles employed in the demonstration are statements of modes of behavior of which the data in that instance are samples. Expansion and contraction are not principles external to the data applied to them from without. If induction were a passage from data to meaning, the meaning being some Platonic essence, numerically distinct from the data, then the elimination theory would be the best that reason could do. If data and meaning defined two separate realms of being, then positive knowledge would be a miracle.

But we are not yet out of the woods, for if we say that data and meaning are identical, all knowledge would be a tautology. We would then say that these data are expansion and expansion is these data.

In the interpretation of the theory of induction

through analysis, we must be careful to avoid the mistake of identifying data and meaning. This mistake is avoided when we recall the position taken throughout the body of this text, namely, that the distinction between data and meaning is not a metaphysical distinction but a logical distinction. Knowing is not a passing from data to meaning or from meaning to data (the eliminative theory) nor an identification of data with meaning (a false interpretation of the theory of induction through analysis), but a utilization of data and meaning as instruments in the reflective analysis of experience. In truth, what we are explaining is neither "these data" nor "expansion"; we are using "these data" and "expansion" as means to the explanation of the action of the soap bubble. The distinction between data and meaning exists only within the context of reflection. It is therefore entirely free from any metaphysical implications. This is another way of saying that logic is an empirical science. Its conclusions may have implications for metaphysics, but it does not start from metaphysics.

Appendix.[1]—The following brief description of

[1] It is the view of the writer of this book that a rigorous analysis of terms, propositions, immediate inference, and the syllogism is of the utmost importance, *provided* it can be done thoroughly. But there is never time within the limits of a semester for thorough treatment. One must choose, then, between a rigorous analysis of formal logic and a

terms, propositions, and the syllogism is appended in order to provide an outline for the further analysis of the syllogism in the event that such an investigation seems desirable.

Since in structure a syllogism is composed of propositions and terms, it will be necessary to make a brief analysis of each.

A term may be defined as a word or group of words which can be used as the subject or predicate of a proposition. For syllogistic purposes terms may be classified into particular and general. A particular term is one that can be applied in the same sense to but one single object of discourse. Thus "the Statue of Liberty in New York harbor" or "John Smith" or "the man who broke the bank at Monte Carlo" are particular terms. A particular term always refers to a definite this or that. All sense data are particular terms. A general term refers to any one of many objects. It is a class name. Thus "book" or "chair" or "flowers" are general terms. They do not refer to any special or particular object but to any member of a group of objects. All concepts, all standardized meanings are general terms.

---

descriptive account of reflective thinking. In choosing to give the analysis of reflective thinking, the writer by no means wishes to disparage the discipline of formal logic.

General terms are further divided by logicians on the basis of distribution. A term is said to be distributed when it refers to all the members of the class; it is said to be undistributed when the reference is to only a part of the class. A distributed term, therefore, is taken in its complete extension; an undistributed term in its partial extension. For example, if "man" is the term in question, I can refer to "all men" or only to "some men." In the former case the term is distributed; in the latter case it is undistributed.

Propositions are classified by logicians according to two different characteristics, quantity and quality. According to quantity propositions are classified on the basis of the distribution of their subjects into (1) Universal, and (2) Particular. According to quality they are classified into (1) Affirmative, and (2) Negative. Thus "All men are rational" is a universal proposition; "Some men are white" is a particular proposition; "Most Irishmen are quick-witted" is an affirmative proposition; "No metals are compounds" is a negative proposition.

Care should be taken in the interpretation of negative propositions. The distinction according to quality is made on the basis of the inclusion or exclusion of classes. When one class is included com-

pletely or partially within another class, the proposition formulating the inclusion is affirmative. When a class is excluded from another class wholly or in part, the proposition stating the exclusion is negative. The distribution of quality is made irrespective of whether the *terms as terms* are positive or negative. For example: "All who are unhappy are unwise" is an affirmative proposition, although both subject and predicate terms are negative terms. The class "unhappy beings" is included within the class "unwise beings." Again, "He is one who is not innocent" is affirmative; the term "he" is put into the class of "those who are not innocent." But if I should say: "He is not one who is innocent," the proposition is negative. "He is one who is not" and "He is not one who is" are accordingly affirmative and negative, the distinction being made on the basis of whether "he" is included in or excluded from a given class.

Since every proposition has both quantity and quality, propositions are further classified on the basis of the combination of the two characteristics into four classes. Using the symbols *S* and *P* for subject and predicate, we have:

(1) Universal and affirmative: All *S* is *P*. (*A*)
(2) Universal and negative: No *S* is *P*. (*E*)

(3) Particular and affirmative: Some *S* is *P*. (*I*)

(4) Particular and negative: Some S is not *P*. (*O*)

Since the above designations of propositions are somewhat cumbersome, and since the distinctions are of such frequent use, logicians have been in the habit of abbreviating the distinctions, and using the four vowels, *A, E, I, O,* as symbols for each of the types of propositions.

Reference should be made to the distribution of terms in propositions. All universal propositions have distributed subjects; all particular propositions have undistributed subjects. In case the subject of a proposition is a singular term, *e.g.,* Socrates is a Greek, the question of distribution does not arise, since distribution applies only to general terms. Logicians are accustomed, for purposes of classification, to construing such propositions, as universal. Thus "Socrates is a Greek" would be classed as an *A* proposition. To determine the distribution of the predicate of a proposition we look to the quality of the proposition. Negative propositions always have distributed predicates. Some *A* propositions have distributed predicates. In these cases, which can be easily recognized, the

subject and predicated terms have the same extensive reference, the two classes coincide. For example, in the proposition, "Socrates is the wisest Greek," the predicate coincides with the subject. In formal definitions, where the predicate is not an accidental attribute, but the *essential* attribute, and therefore always present when the subject defined is present, the two terms are also coincidental. Thus, "All men are rational animals" could be converted into "All rational animals are men;" the quality "rationality" being the characteristic or distinguishing feature of men is always present when man is present. But if I were to say that "all men are vertebrates" the predicate would be undistributed, since there are other animals besides men which are vertebrates. The affirmative propositions which have distributed predicates should be compared with those major premises in hypothetical syllogisms where it is logically valid to deny the antecedent or affirm the consequent.

Attention should be called to certain propositions which are especially difficult to interpret. (1) Such words as "only," "none but," and "except," while affirmative in form are negative in meaning. "Only *bona fide* students play on the football team" is a negative proposition and means that "No students who are not *bona fide* students

play on the football team." It is, therefore, an *E* proposition. (2) The word "few" is also affirmative in form but negative in meaning. For instance, "Few men make *A* grades," means that "some (most) men do not make *A* grades." (3) The words "all . . . not" are often ambiguous. For example, the proposition "All bacteria are not harmful" is a particular negative proposition, and means "Some bacteria are not harmful" and is, therefore, an *O* proposition.

With the above brief analysis of terms and propositions, we may proceed to an analysis of the syllogism. The following rules to which syllogisms must conform in order to yield valid conclusions are usually given by logicians:

(1) In every syllogism, there should be three, and only three terms, and these terms must be used throughout in the same sense.

The terms, as we have already remarked, are known as the major term, the middle term, and the minor term.

(2) Every syllogism contains three, and only three, propositions. These are called the major premise, minor premise, and conclusion.

(3) The middle term must be distributed in at least one of the premises.

(4) No term must be distributed in the conclu-

sion which was not distributed in one of the premises.

(5) From negative premises nothing can be inferred.

(6) If one premise be negative, the conclusion must be negative; and conversely, to prove a negative conclusion one of the premises must be negative.

(7) No conclusion can be drawn from two particular premises.

(8) If one of the premises be particular, the conclusion must be particular.[1]

Failure to observe rule (3) gives rise to the formal fallacy, technically called *Undistributed Middle*. Example: All express trains carry the mail; the last train carried the mail, and was, therefore, an express train. The fallacy underlying this reasoning should be compared with "Plurality of Causes," and also with the hypothetical fallacy termed "Affirming the consequent." The above syllogism, expressed hypothetically, would be: If this is an express train, it carries the mail; it does carry the mail, and is, therefore, an express train.

Failure to observe rule (4) gives rise to two for-

[1] The above statement of rules is taken from Professor Creighton, *Logic*, pp. 115-116.

mal fallacies, technically known as *Illicit Major* and *Illicit Minor*. *Illicit Major* arises when the major term is used distributively in the conclusion but undistributively in the premise in which it occurs. Example: Whoever believes this, is a heretic; so that you are no heretic, for you do not believe this. *Illicit Minor* arises when the minor term is used distributively in the conclusion but undistributively in the minor premise. Example: All Democrats voted against the bill, and as most of our Congressmen are Democrats, they must have all voted against the bill. Rule (1) states that the three terms must be used in the same sense throughout. The middle term is the one most likely to involve an ambiguity. *Ambiguous Middle* arises when the middle term is used in one sense in one premise and in another sense in the other. Example: The right should be enforced by law; suffrage is a right, and should, therefore, be enforced by law. In this case "right" in the major premise is used in a moral sense while in the minor premise it is used in a political sense. The remaining rules of the syllogism should be verified by the student himself.

In the examples given above the syllogism has been used in its complete form. But it often hap-

pens, especially in ordinary reflection, that an abbreviated form of the syllogism is used. For instance we say: He must be a brilliant student for he has made a straight A average. Here one of the premises, all students who make a straight A average are brilliant, is missing. It is mentally understood. A syllogism with one of the propositions missing is called an *Enthymeme*.

It should be carefully noted that it is the *form* which affords the logical basis of validity. The concept of form is somewhat technical and it may be well to illustrate its meaning. We are familiar with the distinction between form and matter. In addition to the material out of which a tapestry is made, there is the pattern in accordance with which the material is arranged. A symphony is not just a sensuous extravagance but the musical notes and phrases are combined into a composition. We speak of the structure of a literary composition, the outline of an argument, meaning to characterize the way in which the material is organized. When, for instance, we speak of a formal garden, we have in mind, in addition to the materials used, the way in which they are arranged so as to produce a pleasing effect. Now thought has its structure. And propositions, in order to yield truth, must be

combined in accordance with certain principles of formal organization. The syllogism is a statement of the structure of thought, when thinking issues in truth.

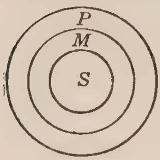
It is the form, then, which gives validity to inference. Aristotle considered the formulation of the formal basis of valid inference as his special discovery. Medieval logicians expressed Aristotle's discovery as the *dictum de omni et nullo*. It means that whatever is predicated affirmatively or negatively of a class may be predicated affirmatively of a member of a class. For example, in the traditional syllogism: All men are mortal, Socrates is a man, therefore, Socrates is mortal; "mortal" is predicated affirmatively of the class "men"; Socrates is a member of the class "men," consequently "mortal" may also be predicated affirmatively of Socrates. This is the *dictum de omni*. As an example of the *dictum de nullo* we may take the following: No envious man is to be trusted; *X* is an envious man, and is, therefore, not to be trusted. "Trusted" is predicated negatively of the entire class "envious men," and since *X* is a member of the class "envious men," "trusted" may also be predicated negatively of *X*.

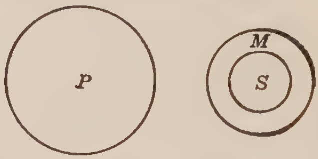
The formal structure of thought may be repre-

sented graphically. Using the symbols *S, M,* and *P* for the terms of the syllogism, we have the two following forms:

Dictum de omni	*Dictum de nullo*
All *M* is *P*	No *M* is *P*
All *S* is *M*	All *S* is *M*
All *S* is *P*	No *S* is *P*

The graphic representations are as follows:





P being predicated affirmatively and negatively, respectively, of the class *M,* and *S* being a member of the class *M, P* is also predicated affirmatively and negatively, respectively, of the class *S.*

It should also be noted that it is the form that carries the inference. It is nothing that we know about mortals and nothing that we know about Socrates that enables us to draw the conclusion. It is the *form* of the syllogism that is the basis of the inference. This is seen when we substitute the symbols *S, M,* and *P.* These symbols may be any possible major, middle, and minor terms, and no matter what content we assign to the symbols, pro-

vided the premises are true, the conclusion will follow *of necessity,* since the premises are what they are.

QUESTIONS

1. Compare the definition of the syllogism given by Professor Creighton with that given by Aristotle.
2. What is the place of the syllogism in reflection?
3. How do you distinguish between hypothetical, disjunctive, and categorical propositions?
4. Explain the structure, rules, and fallacies of the hypothetical syllogism.
5. How do you relate the hypothetical syllogism to the processes of deductive proof? Develop this relation with respect to both major and minor premises.
6. Criticise the reasoning expressed in the examples given on page 392 *seq.*
7. Make a logical analysis of the illustration given on page 342 *seq.*
8. What do you consider to be the chief value of the hypothetical syllogism?
9. Under what conditions may one violate the formal rules of the hypothetical syllogism?
10. Do you consider the affirmation of the antecedent as a case of reasoning? Discuss.
11. How is the disjunctive syllogism related to the hypothetical?
12. What is the distinction between contradictory and contrary propositions? What relation has this distinction to disjunctive reasoning?
13. Under what conditions is disjunctive reasoning valid?
14. Relate Mill's *Method of Residues* to the disjunctive syllogism.

15. Explain the "Eliminative Theory of Induction." What are its implications for truth?

16. Give a full discussion of the status of the categorical syllogism in reflection. Give special attenton to a comparison of the relation between premises and conclusion with that between data and meaning, on the one hand, and knowledge on the other.

17. Explain Kant's statement: "Perceptions without conceptions are blind; conceptions without perceptions are empty." Give a full discussion of this statement in relation to data, meaning, and knowledge.

18. How do you distinguish "Induction through Scientific Analysis" from the "Eliminative" theory? What advance does "Analysis" make over "Elimination" in the direction of positive proof?

19. What two interpretations are given to the theory of "Induction through Analysis"?

EXERCISES

1. Criticise the reasoning in the following:

(a) If data and meaning define separate realms of being, then the eliminative theory of induction is true. But since we know that data and meaning do not define separate realms of being, the eliminative theory is, therefore, false.

(b) When the Caliph Omar burned the Alexandrian library, he is said to have justified himself by saying that if the books in the library contained the same doctrines as the Koran, they were unnecessary, while if they contained doctrines at variance with the Koran they were evil; and since one or the other must be true, the books were either unnecessary or evil. (Bode.)

(c) Everything must have a cause; for if anything wanted a cause it would produce itself, that is, exist before it existed, which is impossible. (Hume.)

2. In the following instance of reflective thinking point out the following logical aspects: (1) what specifically the data are; (2) how the various data were obtained; (3) what errors in obtaining the data were committed; (4) what the cause was of these errors; (5) what meanings are present; (6) what types of meaning there were; (7) how the meanings are related to the data; (8) the syllogistic forms of reasoning implied.

"In the eighteenth century, there was widely accepted a theory that combustion is a process in which substances give off phlogiston. In detail the theory and its proof were as follows: Some substances are seen to burn. Other substances will not burn. When a substance burns, flame ascends, often with considerable force. Something seems to be escaping in the flame. This something was named phlogiston. Substances which contain phlogiston will burn, and substances which do not contain phlogiston will not burn at all.

"The phlogiston theory was further confirmed by the fact that the visible residuum of ashes, left after a substance was burned, was generally less, in both weight and bulk, than the substance was before it was burned. Thus the theory seemed to account for all the facts.

"But by the beginning of the nineteenth century, the above phlogiston theory was completely discredited. Its advocates had failed, in observing the weight and bulk of ashes of a burned substance, to take into account the gaseous products of combustion which had escaped into the atmosphere. When these gaseous products of combustion were taken into account, an entirely different theory of combustion was adopted."

3. In the following example (1) state the syllogisms implied, giving in each case the major and minor premise and the conclusions; (2) state the meanings and the data and show their relation to the knowledge expressed in the conclusions.

"No human being in this country can exercise any kind of

public authority which is not conferred by law; and under the law of the United States it must be given by the express words of a written statute. Whatever is not so given is withheld and the exercise of it is positively prohibited. Courts-martial in the army and navy are authorized; they are legal institutions; their jurisdiction is limited, and their whole code of procedure is regulated by act of Congress. Upon the civil courts all the jurisdiction they have or can have is bestowed by law, and if one of them goes beyond what is written, its action is *ultra vires* and void. But a military commission is not a court-martial, and it is not a civil court. It is not governed by the law which is made for either, and has no law of its own. . . . So these commissions have no legal origin and no legal name by which they are known among the children of men; no law applies to them, and they exercise all power for the paradoxical reason that none belongs to them rightly." (J. S. Black.)[1]

[1] Quoted by J. E. Creighton, *An Introductory Logic,* p. 414.

CHAPTER FOURTEEN

SCIENTIFIC EXPLANATION

Science has been defined as a body of generalized, verified, and organized beliefs. A similar definition is given by Professor Marvin: "*Science is the explicit and demonstrated explanation of all facts.* That is, the business of scientific research is to explain all facts, to make this explanation logically explicit, and to demonstrate rigorously its truth."[1] This is also in accordance with the view expressed by Aristotle, namely, that science is *proved* knowledge; and the "proof" according to Aristotle, consists in pointing out the connection between a belief and the grounds which support the belief. It is this aspect of science which is indicated by saying that science is *organized* knowledge. The identification of explanation with scientific knowledge will be the guiding principle in the following analysis.

One who desires an explanation usually begins by asking questions. If his questions are properly

[1] W. T. Marvin, *A First Book in Metaphysics*, p. 53.

expressed and if only the informer knows enough, the answers given to the questions should be an explanation. Aristotle was the first to draw up a list of questions which one in search of knowledge might ask. There are, Aristotle thought, four leading questions, and the man who can answer these questions is the one who can give an explanation. The word which Aristotle used to express the answers to these questions was *aitia.* We gain a better insight into the purpose of Aristotle's inquiry if we remember that *aition,* the word which is usually translated by our word "cause," is derived from the verb *aiteo,* which means to ask. There are, as we should say, four questions which one can ask about a thing, and when these questions are answered, the thing is explained. The explanation of the thing is what one knows about it. Let us take *X* to stand for any object of explanation. We have an explanation of *X* when we know:

(1) Out of what is *X* made?
(2) What is *X?*
(3) Who or what made *X?*
(4) What is *X* for?

We might answer these questions by saying that *X* is made out of bronze, that *X* is a statue, that *X* was

made by Polyclitus, and that X is used as an ornament of decoration.

The answers to these questions Aristotle termed the material cause, the formal cause, the efficient cause, and the final cause. That is to say, four factors enter into the explanation of anything and the thing has not been completely explained until the four factors have been described. Or to state the position differently, there are four points of view from which one may seek to understand a thing, from the standpoint of the material out of which it is made, from the standpoint of its definition, from the standpoint of its genesis, and from the standpoint of its use. Substances, structure, genesis, and purpose are, therefore, four cardinal concepts of explanation. One of these factors, namely, substance, corresponds to data; the other three correspond to meaning. And since we know that knowledge involves both data and meaning, complete explanation will include a descriptive account of the interrelation of the four factors.

Unity in explanation is sometimes gained by saying that all explanation is description. The statement is altogether true, but altogether unimportant. And it remains unimportant until one further states what is to be included in the description and what is to be left out. All explanation is descrip-

tion, but all description is selection. That is to say, all explanation is relevant to the purpose for the sake of which one sets out to describe things. If there were one all absorbing purpose capable of expressing the entire burden of free intellectual inquiry, explanation might conceivably be reduced to a single type. But human interests are too scattered and human purposes are too varied to be subordinated to one end. The logical validity of different forms of explanation rests on the legitimacy of human interests. The view which is here expressed is that Aristotle's four causes, when disentangled from the implications imposed upon them by his metaphysics and when re-interpreted in the light of modern science, define four cooperative and coordinate concepts of explanation.

1. The Material Cause. The difference between a paper dollar and a silver dollar is describable in terms of the substance out of which it is made. We tell what water is by telling the elements which enter into its composition. When you ask a furniture dealer what a table is, you want to know whether it is made out of mahogany or walnut or oak. To ask what a thing is made of is equivalent to asking what data enter into its composition. It should be remembered, of course, that all data are not necessarily sense data. When, for

instance, we speak of the stuff that heroes are made of, or when we say that faith is the substance of things hoped for, the material factors are not physical things.

Grote says that Greek science was born when men left off asking. Who rains? and undertook to describe the elements entering into the precipitation of moisture. One of the major aims of science is to analyze composite things into substantial elements. A thing is said to be explained when analysis has been pushed as far as it is possible to go. The atomic theory of Democritus was thus the first great system of scientific explanation. The atom was the ultimate concept of explanation because it was thought to be the not-further-analyzable element of structural organization. A similar interest in analysis is expressed by Mr. Edward Free writing on the nature of the atom:

> "Why is coal black and gold yellow? Why is steel strong and wax weak? Why is gasoline explosive while asbestos is unburnable? Why is water a wet liquid at ordinary temperature and a hard, crystalline solid below the freezing point? The answers lie within the atoms."

Analysis is the logical process by means of which the material factor is brought to light. The analy-

sis of a gross total situation into data is, as we have seen, the first step in reflection. It is also an indispensable factor in explanation. But it is *only* a factor. In what has gone before we have found many ways of saying that data are not things known, but means to knowing. We cannot identify knowledge with one of the elements used in a cognitive experience. The analysis of a situation into data is an important step in explanation, but is not itself the whole of explanation. Knowledge involves both data and meaning. We must therefore agree with Aristotle and conclude that the material cause is a factor in explanation, but is not itself a complete explanation. This may be expressed by saying that data are always particular, and explanation can never be had in terms of particulars. And this leads us to the *formal* cause.

2. THE FORMAL CAUSE. The formal factor arises in response to the question: What is *X?* Classification and definition are the two most elementary forms of formal explanation. Classification, as we know, is the basis of all intelligibility. I understand that noise when I say it is thunder. The particular datum has been subsumed under a general concept. I have classified the unknown under the known. Generalization in some form is implicated in all thinking. Herein, of

course, lies the incompleteness of explanation in terms of data alone.

Definition is a more advanced stage of explanation than classification. When, for instance, you ask: What is logic? I reply with a definition. The structure of a formal definition consists in the *genus* and the *differentia*. Neither the *genus* nor the *differentia* is a particular; they are "forms," that is, generalized meanings.

But no one word, such as classification or definition, can carry the full significance of the term "form." The word also signifies what we mean by "principle" and "law." A formal explanation includes a description of the principles involved and of the law which expresses modes of activity. In explaining what a steam engine is, one would have to describe the principles involved in its action; he would have to tell how it works, and the "how" would turn out to be a description of the laws of mechanics. This leads to what is perhaps the most important element in formal explanation, namely, structure.

In explaining a thing the material factor accounts for a description of the parts entering into its composition. But in a full explanation it is just as important to tell how the parts are put together as it is to tell what the parts are. The Pythago-

reans were the first thinkers to make the question of structural organization a matter of scientific study. The structural factor was suggested to them by their study of music. In understanding a musical phrase it is just as important to understand the mathematical relationships obtaining between the notes as it is to have a sensory knowledge of the notes. Pythagoras was the first to discover that the separate notes of the scale bear a definite quantitative relationship to one another. In isolating the factor of form he formulated for science its most important type of inquiry.

Why, we may ask, does a clock keep time? This is equivalent to asking what makes a clock a clock. To answer this question, we would have to do more than describe the size and shape and character of the separate parts, we would have to describe the particular way in which the parts are put together. The purpose of keeping time, the essential thing about a clock, is the result of the arrangement and mechanical structure of the parts. When we know this, we know why the clock keeps time. Structure, therefore, is an important element in explanation.

The concept of structure, when generalized, leads to the scientific conception of mechanism. A mechanical explanation undertakes to account for

the activity of bodies in terms of the order and arrangement of their parts together with their modes of activity. Since the mechanical type of explanation is the prevailing, and one might venture to say almost exclusive, type of explanation of physical science, it will be found profitable to analyze it somewhat in detail.

Let us first adduce illustrations:

"According to Kirchhoff's famous definition (1876), the task of mechanics is 'to describe completely and in the simplest manner the motions which take place in nature.' When we give a mechanical description of an occurrence—the eruption of Vesuvius, the bursting of the broom-pods, or the curling of the non-living tendrils of a mermaid's purse—it is in terms of matter and motion, or in chemico-physical terms which are believed to be reducible to those of matter and motion. The mechanical account is as such entirely satisfactory when it enables us to see a process as a continuous series of necessarily concatenated mechanical operations like those which occur in the slow movement of a glacier, or like the successive explosions which mark the extension of a rapidly spreading conflagration. We shall

use the slightly wider term mechanistic to include either a matter-and-motion description, which is in the strict sense mechanical, or a more dynamical description in which the concept of energy is emphasized, or a chemico-physical description which is ideally mechanical, that is, theoretically reducible to matter-and-motion description, though, as a matter of fact, the reduction may not have been as yet effected. A mechanistic description, in short, is in terms of the fundamental concepts of physics and chemistry; and it is the most precise and most thorough kind of description that is known.

"Given three good observations of a comet, an astronomer who knows his business can prophesy with certainty when, barring accidents, it will return. He may not tell us what gravitation means, or what the comet is made out of, or how it arose, or what it portends to mankind, but of the coming and going he gives a complete account, as the punctual return of the comet afterwards proves." [1]

Let us now see in what sense mechanism is explanation. All explanation, we have said, is rele-

[1] J. Arthur Thompson, *The System of Animate Nature,* Vol. I, pp. 107-108.

vant to the purpose for the sake of which one sets out to describe things. A mechanical explanation has as its chief purpose the formulation of "laws of nature." Thus writes A. E. Taylor:

> "So far as description is undertaken for the purpose of establishing practical rules for intervention in the course of occurrences, this (mechanical) assumption is perfectly justified. If we are to lay down general rules for meddling in the course of events, we must assume that, apart from our meddling, it goes on with routine regularity. And we have already seen that for this very reason the mechanical interpretation of Nature is a fundamental postulate of physical science, so long as it confines itself to the work of formulating 'Laws of Nature,' and does not attempt the task of historical appreciation."[1]

Mechanical explanation consists in referring things to law. Science does not ask "why" bodies fall; it seeks rather to formulate the laws descriptive of falling bodies. When these laws have been formulated, they serve as principles of reference for causal explanation. Mechanism, therefore, is but another word for causality. And causality, as

[1] *Elements of Metaphysics*, p. 309.

we have seen, is a description of the way things happen.

Since mechanism is the prevailing type of explanation in physical science, it may be well to subject it to critical analysis.

It should certainly be said that as an hypothesis—and I do not suppose that any serious scientist regards it as anything more than an hypothesis—mechanism has been one of the most fruitful ideas in the history of scientific thinking. But if the history of philosophy teaches anything, it is that ideas sometimes outlive their usefulness and operate as barriers to further scientific advance. Now I do not believe that mechanism has outlived its usefulness, but there is a very real sense in which it is a barrier to free intellectual inquiry. And that is the sense in which mechanism is taken as the sole form of explanation. The view that all description must necessarily be mechanical rests on the assumption that no other kind of description will answer the purpose for the sake of which we undertake a natural description. If this assumption were true, then mechanism would not be one form of explanation; it would be the whole of explanation. But I do not believe this assumption to be a true one. Its specious truth has come to be held for the following reasons.

Existence as we know it exhibits itself on three well defined levels. These may be termed the physico-chemical level, or the realm of matter; the biological level, or the realm of life; and the cognitive level, or the realm of mind. The physico-chemical level, there is every reason to believe, is chronologically prior to the other two. It was also the first domain to yield to scientific treatment. The materialism of Democritus was the first great system of scientific explanation. As Mr. Santayana remarks: "With Democritus, physics became scientific, when before it was but spectacular." The system of Democritus is the most thorough-going system of mechanical explanation anywhere to be found in the history of logical literature. It has remained the model for a science of nature. Explanation was first worked out in the realm of matter, and in this domain mechanism has seemed the last word.

But then the biological and psychological sciences have sprung up. What should have been done was not done. The biologist should have recognized the independence of his science and have worked out a set of explanatory concepts in terms of the nature of his subject-matter. But this was not done; instead, the biologist took over the already existing concepts from physics and chemis-

try and undertook to explain biological phenomena in terms of them. This procedure led inevitably to the reduction of life to matter. The mechanistic conception of life is the outcome of a methodological blunder.

Descartes was among the first in modern times to institute this methodological abstraction. His theory of animal automatism is an example of the carrying over of the concepts of physics and the application of them to the domain of life. In a famous passage, after enumerating the most important of the bodily functions, such as the pulsation of the heart, digestion, respiration, *etc.,* he writes:

> "I desire, I say, that you should consider that these functions in the [bodily] machine naturally proceed from the mere arrangement of its organs, neither more nor less than do the movements of a clock, or other automaton, from that of its weights, so that, so far as these are concerned, it is not necessary to conceive any other vegetative or sensitive soul, nor any other principle of motion, or of life, than the blood and the spirits agitated by the fire which continually burns in the heart, and which is in no wise essentially different from all the fires which exist in inanimate bodies." [1]

[1] Quoted from *Traité de l'Homme,* p. 427, by T. H. Huxley, *Method and Results,* Lecture IV.

Similarly, writes de la Mettrie:[1]

> "The human body is a machine which winds its own springs. . . ."[2]
>
> "If these springs differ among themselves, these differences consist only in their position and in their degrees of strength, and never in their nature; wherefore the soul is but a principle of motion or material and sensible part of the brain, which can be regarded, without fear of error, as the mainspring of the whole machine, having a visible influence on all the parts. . . .
>
> "The body is but a watch, whose watchmaker is the new chyle."[3]

Contemporary psychology has followed the same procedure. The psychologist, with a great experimental gesture, cut loose from philosophy. He was eager to establish himself as a scientist. Now science meant for him the achievements of physics and chemistry. Instead of investigating mental life in terms of its own subject-matter, attempting to work out a set of psychological concepts germane to the nature of mental life, the psychologist took over the concepts of mechanical science, and attempted to formulate his descriptions

---

[1] De la Mettrie (1709-1751), a French philosopher.

[2] *Man a Machine,* Eng. tr., G. C. Bussey, p. 93.

[3] *Ibid.,* p. 135.

in terms of them. The procedure both in biology and in psychology is dominated by the assumption that the only legitimate purpose of scientific description is the formulation of laws. The legitimacy of this assumption will be considered later.

The most serious charge to be brought against mechanism is that it is responsible for the most misleading of all philosophies, the philosophy of "at-bottom-ism." This is the "nothing but" philosophy. Its prevailing method is that of reduction. In order to exhibit the character of this method, let us take an illustration. We will take an example which involves explanation. I will suppose that I am a member of a club composed of a political scientist, an experimental psychologist, a biologist, a chemist, and a physicist. Then I will suppose that I have been appointed by the club to read a paper. I begin my paper by asking a question: Why am I here reading words from a paper? The political scientist would say that I am a member of a group and that it is in response to the sovereign will of the group that I am here. The use of the word "will" would at once attract the psychologist. He would say that the analysis of will was a psychological problem. The political explanation would then be reduced to psychological explanation. The psychologist would attempt to explain my action

in terms of the physiology of the nervous system. At this point, the biologist would say that physiological psychology was a branch of the broader subject of biology. He would say that I am here because my heart is beating and because my stomach is digesting food and because my nervous system is performing its function. The chemist would have the right to say that all vital functions depend upon chemical changes. The passage of a nervous current along a neurone is, in part at least, a chemical process; the shunting of a nervous current at the synapse is due to the metabolic conditions of nervous tissues, and metabolism is a chemical problem. Biology, therefore, is nothing but chemistry. And the physicist, of course, would say that all chemical properties depend on inter-atomic structures, and that until these structures are known, no explanation can be given. So then what we started with, an apparent mental fact, has been *reduced* to the level of mechanical physics. And since we are at present unable to carry our analysis any further, explanation is "at bottom" *nothing but* mechanism.

The view that mechanism is the sole form of explanation thus gains confirmation from the methodology of reduction. Since there is good evidence to show that the vital and cognitive levels of existence are evolutionary products of the chemico-

physical, the conclusion is drawn that life and mind are nothing but modes of matter and motion. And since the mechanical hypothesis seems adequate within the chemico-physical realm, it is also concluded that all explanation is reducible to the mechanical type.

In opposition to this view, two things may be said. The first is that it contains a confusion of origins and values. "Is not this the carpenter's son?" is a notable attempt to discredit one's value by disclosing his origin. The significance which attaches to a thing after it has come into being is altogether independent of its origin. Values are determined by use and not from origin. Thus writes Plato:

> "Are not the excellence, beauty, and correctness of every manufactured article or living creature, or action, to be tried only by reference to the purpose intended in their construction, or in their natural constitution?"[1]

The emergence of the concept of value carries us beyond the limits of mechanism. A more detailed account of the relation of value to explanation will be considered when we come to the final cause.

But in the second place, even granting the logi-

[1] *Republic*, 601 c.

cal possibility of reducing all the stray and scattered facts of the world to a single principle, it must be remembered that reduction does nothing to alter the character of the things reduced. Heat may be explained as "nothing but" the movements of molecules. But this explanation in no way alters the quality of what I feel as heat. Heat loses nothing of its unique qualitative character in being reduced to quantity. In point of reality, heat has not been reduced at all, the physicist has merely discovered a quantitative equivalent of heat.

Our net conclusion is this: It is not that mechanism is untrue; it is that it is incomplete. Its incompleteness lies in its total inadequacy to provide a basis for criticism or any standards for evaluation. In a mechanistic scheme, one thing is as good as another. But criticism and evaluation are legitimate human interests. Suppose that the scientist succeeds in giving a mechanistic description of all the facts in the universe, then we should ask: What of it? What do all these facts mean? The laws of nature, when taken impersonally are without value; but what is their significance when taken in relation to human experience? The incompleteness of mechanism as the sole form of explanation rests on the legitimacy of these questions. No description can claim to be complete until it satisfies all

questions that may be rightfully asked. Mechanism leaves untouched the fourth of Aristotle's questions, and gives but scanty recognition to the third.

3. The Efficient Cause. The efficient cause arises when we seek to explain the succession of events in time. It, therefore, corresponds more closely to the popular meaning of cause. The formal cause tells what a thing is, the efficient cause tells *why* an event occurs. The two types of inquiry express different viewpoints. The formal cause views things statically; the efficient cause views them dynamically. In dealing with events or occurrences in time, we seek to discover the agencies and factors which account for their appearance. For example, alcohol is the efficient cause of intoxication; the formal cause would tell what intoxication is.

We have already seen that popular reflection and practical science are interested largely in control. To obtain results, either in the form of accomplishing desirable ends or in avoiding undesirable ones, it is important to know why events occur, or how ends are gained and results produced.[1] Efficiency becomes a matter of importance when we are con-

[1] What was said regarding "cause" in terms of *control* in the chapter on "Causality" should be re-applied here.

cerned with production and development. When experience is viewed dynamically as a succession of events in time, genesis rather than structure is the controlling concept. The physician, for instance, would be interested in both form and efficiency. He wants to know what malaria is and he also wants to know how to cure it. The bite of the mosquito is the efficient cause of malaria; quinine is the efficient cause of its cure.

Reference has already been made to genetic definition. We tell what a thing is by telling how it has come to be what it is. One may, for example, explain what water is by describing the ways in which it is produced. Explanation in terms of origins is a form of explanation which is often practically useful and logically legitimate.

Structure when generalized gives rise to mechanism. Genesis when generalized gives rise to the concept of evolution. The following passage is a description of the meaning of evolution:

> "Organic evolution means that the present is the child of the past and the parent of the future. It is not a power or a principle; it is a process—a process of becoming. It means that the present-day animals and plants and all the subtle interrelations between them have

arisen in a natural knowable way from a preceding state of affairs on the whole somewhat simpler, and that again from forms and interrelations simpler still, and so on backwards and backwards for millions of years till we lose all clues in the thick mist that hangs over life's beginnings."[1]

The logical value of evolution as a concept of explanation may be seen from the following description:

"In these days we have become familiar with the notion of evolution or development, and the application of this notion has proved of the greatest service to science, and particularly to those sciences which deal with the phenomena of life. What is characteristic of this manner of regarding things is the fact that it does not consider the various phenomena with which it deals as fixed, unchangeable things, each with a ready-made nature of its own. But each thing is simply a stage of a process, a step on the way to something else. And the relations of the various phenomena to each other, their connection and unity as parts of the one process, come out more clearly when

[1] *The Outline of Science,* Vol. I, p. 56.

viewed in this way. In other words, by taking a survey of the genesis and growth of things, or the way in which they come to be, we gain a truer idea of their nature and relations than would be possible in any other way. The past history of any phenomenon, the story of how it came to be what it is, is of the greatest possible service in throwing light upon its real nature. Now, one cannot doubt that this conception will also prove serviceable in the study of logic."[1]

It should be remembered that evolution is an explanation of only one aspect of things, namely, their genesis. Care must be taken to limit genetic explanation to what it really is. Evolution is no power or cause; it is only the description of a process. Still when the series of changes and transformations in animal existence is viewed in this way their relations and sequences are better comprehended and understood. Care must also be exercised in keeping value separated from origins. The way a thing has originated has little or nothing to do with the value which accrues to it after it has come into being. The emergence of the concept of value leads us to Aristotle's fourth cause.

[1] J. E. Creighton, *An Introductory Logic,* pp. 316-317.

4. THE FINAL CAUSE. Aristotle's *Ethics* opens in the following manner:

> "Every art and every scientific inquiry, and similarly every action and purpose, may be said to aim at some good. . . .
>
> "As there are various actions, arts, and sciences, it follows that the ends are also various. Thus health is the end of medicine, a vessel of shipbuilding, victory of strategy, and wealth of domestic economy."

In this passage the point of view shifts from the past to the future. To grasp or comprehend an action, one must know the purpose for which the action is being performed. For example, observing a man rushing in the direction of a railroad station, I infer that he is running to catch a train. The end which he has in mind is said to explain his action.

The final cause arises in response to the question: What is *X* for? Function, value, purpose, use, are inquiries set by this type of question. In asking it we pass from structure and genesis to function. Anatomy, for example, describes the structure of the body, while physiology is concerned with function.

Let us first seek to mark out the sphere in which

purpose is a legitimate explanatory concept. We may take as a guiding principle the statement that purpose is a legitimate explanatory concept in those cases in which function cannot be deduced from structure. Activity is characteristic of all existence. The stars shine, the planets revolve around the sun, material bodies gravitate, watches keep time. In each of these cases, the resulting action is the necessary and natural outcome of structural organization. It is not the purpose of the planets to revolve around the sun, but the mechanical system in which they move and have their being, being what it is, their movements cannot be otherwise than what they are. In these cases, function is explained in terms of structure. It would seem, then, that purpose is not an ultimate category of physical science. What physical things do can be explained in terms of matter, form, and efficiency.

When we leave the realm of inorganic things (the chemico-physical level of existence) and enter the realm of living things (the vital level of existence), purpose seems more germane to explanation. Whether purpose is an ultimate concept of explanation in the realm of biology is a matter of much debate. A biologist like Professor Jacques Loeb, for instance, thinks that all vital phenomena can be explained in terms of the basal concepts of

physics and chemistry. This view is of ancient origin. For a classical expression of it we may turn to the Latin poet, Lucretius:

> "Herein you must eagerly desire to shun this fault, and with foresighted fear to avoid this error; do not think that the bright light of the eyes was created in order that we might be able to look before us, or that, in order that we may have power to plant long paces, therefore the tops of ankles and thighs, based upon the feet, are able to bend; or again, that the forearms are joined to the strong upper arms and hands given us to serve us on either side, in order that we might be able to do what was needful for life. All other ideas of this sort, which men proclaim, by distorted reasoning set effect for cause, since nothing at all was born in the body that we might be able to use it, but what is born creates its own use."[1]

In a similar vein writes Spinoza:

> "There will now be no need of many words to show that nature has set no end before herself, and that all final causes are nothing but human fictions."[2]

[1] Lucretius, *On the Nature of Things,* Eng. tr., C. Bailey, p. 171.
[2] Spinoza, *Ethics,* Eng. tr., White and Stirling, p. 41.

In opposition to the mechanistic view just described we may cite the view of J. Arthur Thomson:

> "There has not yet been given any physico-chemical description of any total vital operation. . . ."[1]
>
> "The inadequacy of the mechanical description is apparent when we consider any function in its totality. There is a correlated sequence of events, and it is the correlation that is characteristic. One group of cells has not only to do its own work, but has to keep in exact coordination with the working of other groups, sometimes at a distance. It goes without saying that we know a good deal about this internal regulation—we do not expect action without means—but we cannot give a complete chemico-physical account of it."[2]

Professor Thomson gives the following as an illustration of an activity which cannot be described totally in mechanical terms:

> "In the remarkable life-history of the liver-fluke of the sheep, microscopic ciliated larvae emerge from egg-cases which have fallen into

[1] J. Arthur Thompson, *The System of Animate Nature,* Vol. I, p. 117.
[2] *Ibid.*, pp. 118-119.

water. These larvae have no organs in the strict sense, no hint of a nervous system, and only few cells altogether. They have energy enough to go on swimming for about a day in the water-pool. They may come in contact with many things, sticks and straws, roots of aquatic plants and various aquatic animals, but there is (in Britain) only one touch to which they respond—that of the small fresh-water snail, *Limnaea truncatula,* the only host that will enable them to continue their life-history. When they touch the mollusc, they work their way into it and exhibit a remarkable succession of multiplication and metamorphoses. The point is that a minute, brainless creature responds at once to the one stimulus which will enable it to continue its life."[1]

Professor Thomson states his conclusion in the following manner:

"The result of our consideration is that while mechanical description has its place and utility in the organic domain, it is inadequate to cover the characteristic facts of every-day

[1] *Ibid.,* pp. 123-124.

function, of animal behaviour, of individual development, and of racial evolution.

"Our study has led us away from the view that there is only one science of nature, consisting of precise chemico-physical descriptions which have been, or are in process of being, summed up in mechanical or mathematical terms. As it seems to us, there is greater utility and accuracy in frankly recognizing successive orders of facts, each with its dominant categories. There is the domain of the inorganic, the physico-chemical order, where mechanism perhaps has it all its own way. There is the realm of organisms, the biological order, where mechanism is checkmated by organism. There is the kingdom of man, the social order, where mechanism is transcended and personality reigns." [1]

The logician is not called on to take sides in the contemporary controversy between mechanism and teleology [2] in the sphere of biology. In so far as teleology is used as a type of explanation, it is the purpose of the logician to analyze the concept.

[1] *Ibid.*, p. 133.

[2] The concept of purpose, when generalized, gives rise to the concept of teleology.

The empirical fact is that things are explained in terms of the purposes which they subserve, and that the concept of purpose is of greater significance in some realms than in others. We have previously seen that it was necessary to separate purpose from origin, and to note that things have a use and value that is quite independent of their origin. We must now observe that there are realms in which, in the interest of explanation, it is important to separate function from structure. The separation may be made for methodological purposes only, but even so, it is important to recognize that inquiries differ not only in respect to their subject-matters but also in respect to "their characteristic questions and methods and concepts." [1]

Inquiries also differ in respect to the *unique* character of the subject-matter under investigation. That is to say, the difference between a chemico-physical process and a vital process is a descriptive difference. This difference may be explained in terms of the distinction between "results" and "ends." On this distinction we may quote Professor Dewey:

> "Any exhibition of energy has results. The wind blows about the sands of the desert; the

[1] J. Arthur Thompson, *The System of Animate Nature,* Vol. I, p. 134.

> position of the grains is changed. Here is a result, an effect, but not an *end*. For there is nothing in the outcome which completes or fulfills what went before it. There is mere spatial redistribution. One state of affairs is just as good as any other. Consequently there is no basis upon which to select an earlier state of affairs as a beginning, a later as end, and to consider what intervenes as a process of transformation and realization.
>
> "Consider, for example, the activities of bees in contrast with the changes in the sands when the wind blows them about. The results of the bees' actions may be called ends not because they are designed or consciously intended but because they are true terminations or completions of what has preceded."[1]

This distinction is a purely descriptive distinction. And explanation should proceed on the basis of this empirical and factual description. If explanation is description, then no description is complete which does not include a description of ends. The last term in a vital series is of course a result, but it is more than a result; it is an end.

Now when we pass to the cognitive level of exist-

[1] J. Dewey, *Democracy and Education*, pp. 117-118.

ence, we must distinguish between "ends" and "aims." Ends express design, but not prevision. The animal feels the burden of its tendency without seeing the form of its completion. An end becomes an aim when its content is conscious and when its objective is desired. Values may then be projected where they cannot be sensed. Ends are adjusted results; aims are conscious ends. Let us then use the terms "results," "ends," and "aims" to characterize the activities of matter, life, and mind, respectively. It will both simplify and clarify our discussion if we divide teleology into two kinds. One we will call adaptation. This form of teleology applies to the biological realm of ends. The other we will call purpose, and this kind of teleology applies to the psychological realm of aims.

In the entire realm of logical literature, there is nowhere to be found a more pertinent protest against the tendency to consider mechanical description as the sole form of explanation than in the language of Plato. In the *Phaedo,* Socrates is represented as having read a book written by the philosopher, Anaxagoras, in which it was given out that mind was "the disposer and cause of all." Socrates was delighted with this because he thought he was going to have things explained in terms of their aims and values. The eagerness with

which Socrates got the book and the disappointment that followed its readings are thus described by Plato:

> "What hopes I had formed, and how grievously was I disappointed! As I proceeded, I found my philosopher altogether forsaking mind or any other principle of order, but having recourse to air, and ether, and water, and other eccentricities. I might compare him to a person who began by maintaining generally that mind is the cause of the actions of Socrates, but who, when he endeavored to explain the causes of my several actions in detail, went on to show that I sit here because my body is made up of bones and muscles; and the bones, as he would say, are hard and have ligaments which divide them, and the muscles are elastic, and they cover the bones, which have also a covering or environment of flesh and skin which contains them; and as the bones are lifted at their joints by the contraction or relaxation of the muscles, I am able to bend my limbs, and this is why I am sitting here in a curved posture: that is what he would say, and he would have a similar explanation of my talking to you, which he

would attribute to sound, and air, and hearing, and he would assign ten thousand other causes of the same sort, forgetting to mention the true cause, which is, that the Athenians have thought fit to condemn me, and accordingly I have thought it better and more right to remain here and undergo my sentence; for I am inclined to think that these muscles and bones of mine would have gone off to Megara or Boeotia,—by the dog of Egypt they would, if they had been guided only by their own idea of what was best, and if I had not chosen as the better and nobler part, instead of playing truant and running away, to undergo any punishment which the state inflicts. There is surely a strange confusion of causes and conditions in all this. It may be said, indeed, that without bones and muscles and the other parts of the body I cannot execute my purposes. But to say that I do as I do because of them, and that this is the way in which mind acts, and not from the choice of the best, is a very careless and idle mode of speaking."[1]

Assuming, then, that "historical appreciation," or what is the same thing, explanation in terms of

[1] *Phaedo*, 98-99.

purpose, is a legitimate type of inquiry, let us attempt an analysis of the concept of purpose as that concept is employed in reflective experience, that is, in the third realm of being,.namely, the mental. We may begin with an illustration. I am, let us say, sitting at the dinner table engaged in conversation. Suddenly, I notice that it is growing dark. It then occurs to me that I left my car on the street with the lights turned off. I then reflect that if this is discovered by the police I shall have to pay a fine. Not wishing to be fined, I go out and turn on the lights.

An interpretation of this simple act of reflective experience may be undertaken from two points of view: (1) from the point of view of the performer of the act; and (2) from the point of view of an outside observer who undertakes to explain the action. We will give the interpretation from the standpoint of the performer first. In doing this we shall confine ourselves to a factual description of just what took place.

A factual description includes the following order of events: (1) Being seated at dinner engaged in conversation (non-reflective experience); (2) The noting of approaching darkness (a significant datum); (3) The thought that the lights are turned off (a meaning); (4) The inference that if this is

discovered by the police I will have to pay a fine (a conceptual inference); (5) The desire to avoid the payment of a fine (an impulse that serves as the basis for the reorganization of activity); (6) The ensuing act involving the going out and turning on of the lights (reorganized activity).

Now, from the standpoint of the performer of the act, is there anything in this series of events which can be called a "purpose"? We must answer, No. But let us be clear as to what we mean by "purpose" when we say that there is no purpose in the action. In our analysis of causality it will be recalled that there was a sense in which the existence of causality was denied; namely, in the sense of an existent physical force (a reality in the chemico-physical realm). In a similar way, when the existence of purpose is denied, the denial is made of the existence of any identifiable psychological entity which may be termed "a purpose" (a reality in the mental realm). The foregoing factual description yields a datum which precedes an impulse and an implication. The implication connects directly with the impulse and the action follows immediately upon the connection. When it is said that there is no "purpose," it is meant that there is no third something, a *tertium quid,* in addition to the impulse and the implication, which can

be identified as the purpose. That is to say, a description of the events may be represented as: impulse-implication-action; or as impulse-implication-purpose-action. In the latter representation, it is meant that the "purpose" is an additional factor, some identifiable psychological entity capable of empirical description, some sort of assertive resolution intervening between the implication and the action. Now I think we must deny the existence of any such teleological factor. Purpose is nothing in the way of a psychological entity as causality is nothing in the way of a metaphysical entity.

Let us now turn to an interpretation of the illustration from the standpoint of the observer, who undertakes to explain the action. From his point of view it seems obvious that I went out for the purpose of turning on the light. It should be noted that the observer does not observe the purpose. He observes only my going out and my turning on the light. The purpose is an inference, not an observed fact. It seems then that purpose is a concept which the observer uses in giving an explanation of what has happened. Our conclusion is that purpose is a concept of explanation, but is no force in experience.

Purpose and causality occupy a similar logical

status. Neither is an empirical fact. Causality is not a metaphysical entity; it is a concept of explanation. Purpose is not a psychological entity; it too is a concept of explanation. That is to say, purpose is an ideal element in the interpretation of experience, but is not itself an object of experience. Purpose, like causality, inhabits the realm of essence but not the realm of existence, the distinction between these two realms being one which in the interest of logical analysis it is important to make. And as in the case of causality we undertook to describe the way things happen when they are interpreted in terms of mechanism, so now we must describe the way things happen when they are interpreted in terms of purpose.

The dominant trait of experience when it exhibits purpose is found in the deliberative selection of means to conscious ends. Mechanism is a description of the way things happen when they are interpreted in terms of cause and effect. Teleology is a description of the way things happen when they are interpreted in terms of means to ends. The mechanism-teleology controversy seems to grow out of the failure to note the intrinsic continuity of means to ends. The two cannot be separated. The end determines the means, and the means accomplish the end. A mowing machine is

a mechanism, but it is such only because it is designed to mow. And mowing, as an end, could never be accomplished except by means of the mechanism enlisted in its support. Mechanisms are purposeful and purposes are mechanical. Mechanism without teleology is the play with Hamlet left out; teleology without mechanism is Hamlet with the play left out.

Summary.—There is no one form of explanation to which all other forms are reducible. The concepts of explanation are in part relative to the purpose we have in mind. Substance is a concept of explanation when our purpose is the analysis of experience into its elementary forms. Causality is a concept of explanation when our interest centers in prediction made on the basis of the discovery of the laws of nature. Efficiency is a concept of explanation when we undertake to control the course of events. Purpose is a concept of explanation when our interest lies in the direction of selection, criticism, and appreciation.

But explanation is not only relative to the purpose we have in mind; it is also relative to the empirical differences discoverable within the limits of description. Matter, life, and mind, when projected on to the plane of pure description, exhibit unique differences which are identifiable and

observable. The characteristic activities expressive of these three realms of existence may be termed results, ends, and aims. The concepts of explanation are to be worked out in terms of the characteristic natures of these processes. Mechanism seems adequate for the explanation of results.

Each of the higher forms of activity is all that the lower form is, but it is also something more. And the "more" is something which can be identified as an empirical fact. Thus an end is a result *plus* adaptation. And adaptation is a factual addition. It is only when we say that an end is nothing but a result that we forsake teleology for mechanism. An aim is a result *plus* an end *plus* a meaning. Evolution is both preservative and emergent. It conserves what went before and adds an increment of novelty. Meanings operate in experience. And when they do, experience has a different character from what it has when they do not. It is the character of meaning that gives to experience the quality of aims. If evolution is preservative, then all experience has a mechanical aspect. But to say that it is nothing but mechanism, is wilfully to ignore the emergent factors.

Causality and purpose are purely descriptive terms. If what we are describing are results, the description is wholly mechanical. If what we are

describing are ends and aims, the description is *both* mechanical *and* teleological. But not all the terms entering into a description are to be found among the events described. Causality and purpose are not given actualities of experience. Results, ends, and aims exist. But the concepts used in the interpretation of experience cannot be projected on to the same plane of existence as the data to be interpreted. They are not facts to be explained; they are concepts of explanation. If causality were a thing, and if purpose were a force, all knowing would lapse into being, and all being would appear in the form of particulars. Mind would then have no existence, and interpretation would have no method.

INDEX

L

M

N

O

P